SCIENCE EDUCATION

Formerly GENERAL SCIENCE QUARTERLY

SERVING TEACHERS IN ELEMENTARY SCHOOLS,
JUNIOR AND SENIOR HIGH SCHOOLS, COLLEGES,
AND PROFESSIONAL SCHOOLS FOR TEACHERS

VOLUME 30 | OCTOBER, 1946 | NUMBER 4

CONTENTS

The Social Implications of the Atomic Bomb ..... *Harold C. Urey* 189

Using Demonstrations for Providing Pupil Experiences in Thinking ..... *G. P. Cahoon* 196

Organization of a Basic Science Course ..... *W. C. Van Deventer* 201

Alcohol: What It Does for Man; What It Does to Man ..... *H. B. Haag* 206

The Correlation of Biology and Literature ..... *Alfred F. Nixon* 210

A Study in the Correlation of Educational Activities Through a Functional Demonstration Museum ..... *Michael Serene* 216

The Ability to Test Hypotheses ..... *Morris L. Alpern* 220

The "New" Science: Shall We Decide What to Teach? ..... *Alexander Frazier* 229

Enriching the High School Science Curriculum ..... *William E. Ward* 232

General Physics and Modern Electrical Communication ..... *Reuben Benumof* 236

Abstracts 240

Book Reviews 243

Copyright, 1946, by SCIENCE EDUCATION, INCORPORATED

(The Contents of SCIENCE EDUCATION are indexed in the Education Index)

INTRODUCING THE CONTRIBUTORS

The Social Implications of the Atomic Bomb is one of the most significant *warnings* ever made by an American scientist. Hoosier-born DR. UREY is regarded at present as probably our most socially-minded scientist. He feels very deeply the almost unimaginable responsibilities that the production of the atomic bomb has placed on scientific research workers, and indeed on the American people as a whole. Dr. Urey was awarded the Nobel Prize in Chemistry in 1934 for his discovery of heavy hydrogen (dueterium). Awards in recognition of his outstanding contributions include the Willard Gibbs Medal, Davy Medal, and Franklin Medal. Professor of Chemistry at Columbia University 1929–1939, he holds B.S. and Sc.D. degrees from Montana University; Ph.D. and Sc.D. degrees from the University of California.

DR. G. P. CAHOON has an Ed.D. from the University of California. For some time a teacher of science at University High School, Oakland, California, he has been at Ohio State University since 1935. Dr. Cahoon has served as Vice-president and President of the National Association for Research in Science Teaching.

DR. W. C. VAN DEVENTER received M.A. and Ph.D. degrees from the University of Illinois. Formerly on the staff of St. Viator College (Illinois), he has been at Stephens College since 1938.

DR. H. B. HAAG is one of our best known research workers in problems relating to alcohol. He has written some 80 articles on various pharmacological topics. He is co-author (with Dr. J. A. Waddell) of *Alcohol in Moderation and Excess.* He holds Ph.G. and M.D. degrees from the Medical College of Virginia.

DR. ALFRED F. NIXON has B.S. and M.S. degrees from the University of Chicago; Ed.D. degree from New York University. He taught two years at Alabama State Teachers College, Montgomery, and since then at Dunbar High School, Washington, D. C.

MR. MICHAEL SERENE has B.S. and M.A. degrees from Kent State University. He has taught science at Ravenna Township Schools (Ravenna, Ohio) and at Ambridge High School (Pennsylvania) where he has been assistant principal since 1943.

DR. MORRIS L. ALPERN received B.S. and M.S. degrees from the City College of New York; Ph.D. degree from New York University. Chairman of the Science Department at the Tottenville High School, he has taught science for several years in the public and private high schools of New York City.

MR. ALEXANDER FRAZIER is curriculum coordinator in the Secondary Division of the Los Angeles County Schools.

DR. WILLIAM E. WARD, Head of the Science Department at the Fort Worth-Handley High School the last twelve years, has B.S. and M.A. degrees from the University of Washington; Ed.D. degree from the University of Texas. Teaching experience includes eight years in the state of Washington and thirteen years in Texas.

DR. REUBEN BENUMOF has B.S. degree from the College of the City of New York; B.S. (Engineering), M.S. and Ph.D. degrees from New York University. He has had twelve years teaching experience as well as several years industrial experience.

SCIENCE EDUCATION

VOLUME 30 OCTOBER, 1946 NUMBER 4

THE SOCIAL IMPLICATIONS OF THE ATOMIC BOMB*

HAROLD C. UREY

Institute of Nuclear Studies, The University of Chicago

ON DECEMBER 2, 1942, under the West Stand of Stagg Field at the University of Chicago, there occurred an event which marks a turning point of first magnitude in history. This was the generation of heat at a constant, steady level from atomic reactions. This was a first miniature power unit, a prototype of power units which may be developed in the years to come and which may have enormous industrial importance.

On July 16, 1945, in the deserts of New Mexico, occurred another event in which atomic energy was liberated in the form of an explosive chain reaction. This event also marks a transition from the past in the use of atomic energy for destructive purposes. These events will influence our lives for years to come, and in fact, will influence all of history in the future. If the former of these is predominant in the future, we may expect increased well-being for men; while if the latter becomes predominant in the future, we may expect that civilization as we know it today may be destroyed, never to rise again. In view of these spectacular events of the last years, it is well for thoughtful people to consider carefully what the future may bring, and to exercise if possible some choice in regard to future events.

During the first years of this century, there was another great development, though I believe not so important as the release of atomic energy. I refer to the invention of the airplane, by which invention man conquered a new element. During the 40-odd years since that discovery, the airplane has been used both for peaceful and war purposes. Today, if we try to assess the good and the evil which has been done by the airplane, I think we must conclude that the net effect has been a curse to humanity. The destruction which it has wrought in the world cannot be compensated by its peacetime uses. If we allow events to take the same course in the future as they have taken in the past 40 years, we may expect that a similar appraisal of the merits of atomic energy will be made 40 years from now; and I think the conclusion undoubtedly will be that the evil of atomic energy will have been far greater than its contribution for good. At this time, we are at the turning of the ways, and it is therefore of first importance that we consider carefully what the future holds with respect to this new form of energy, a form of energy which was stored in the nuclei of atoms from the beginning of the earth, the solar system, or perhaps the beginning of the sidereal universe.

These discoveries of nature's laws and the inventions based upon them are not in themselves evil, for it is only the use which men make of these things that leads to constructive or destructive results. Perhaps man has no free will that enables him to

* Address delivered at a meeting of the midwest Independent Citizens Committee of the Arts, Sciences and Professions (Chicago), February 25, 1946.

make a free choice in regard to such matters, and history must roll on its inevitable course. And then again, perhaps man can make a choice, and since all of us behave as though this were the case, we should attempt to make a proper decision in regard to the use of atomic energy. To us at this time the most important problem facing all humanity is the problem of proper control and proper development of atomic energy. Our decisions which we make in this very year will influence the course of history for many years to come. Very seldom does the opportunity and the responsibility come to man that we face in this critical year of 1946.

The problem of the atomic bomb is not primarily the problem of that instrument of warfare. The problem is war itself. It is war that drove men to produce this weapon against their wishes and desires and better judgment, for there were few men working on this weapon who did not realize that it was wholly evil, that it would lead to the death of many men, and that it would be a constant threat over all men for all future time. It is war that drives men and women in all walks of life to pervert their constructive instincts to destructive purposes. It is war that is the real problem of this year, and the decision in regard to this problem is the one which will determine whether it is to be a solution of the atomic energy problem.

The problem of war is a very old problem, and has been with man from the time that he first organized his kind into societies; and this age-old problem is one which perhaps cannot be solved at all. However, the present situation results from a very special kind of war, one in which the destructive powers of men have increased to such an extent because of the application of science to technical problems, particularly in this century. I wish to review briefly the situation as it has developed in recent years.

During the Twentieth Century a revolution has occurred in our methods of production which had its roots in the Nineteenth Century, as all important revolutions of this kind have their roots in the past. During this century we have learned to make use of mass production methods for the production of peacetime goods. These methods depend upon a scientific and engineering background, but they also depend upon a purely economic invention, namely, the Limited Liability Corporation, which first made possible enormous accumulation of capital, and upon management techniques that have developed along with these Corporations and the scientific and engineering foundation for manufacturing processes. At about the year 1900, a very large fraction of all the materials which people used were manufactured or produced near the points at which they lived, mostly by hand manufacturing methods. (I myself as a boy in Indiana saw a barn built from hewn timbers). At the present time, nearly everything which is used by people in the United States is the product of mass production techniques. This revolution has occurred in the brief span of this last half-century, and our high standard of living today is due to these methods of production. Also, with their use it is possible to bring a high standard of living to all the peoples of the world, providing natural resources and other local conditions are at all favorable.

During this same time, we had two brief periods during which we were able to apply these same methods of production to the arts of war. During World War I the machine gun, tanks, airplanes, and submarines were first used on a large scale, and their methods of mass production explored in what is today a rather minor way. By the aid of such weapons, a narrow strip across the north of France and Belgium was laid waste, and a very considerable number of ships were destroyed. Those of us who lived during the last war recall vividly our reaction to the destruction wrought in that war, though today it seems to be only minor in importance. The air-

plane particularly was given a considerable impetus for its development during that war, though it did not contribute greatly to the destruction wrought.

During the years between the two World Wars, but minor development of war weapons took place, especially in this country, where the arts of mass production have been developed to the greatest extent. But during World War II these methods were applied on a vast scale to the mass production of weapons of the last war and the methods of research and development were applied to introduce new weapons of great magnitude. Among these we may mention radar, the proximity fuse, many details for the detection and destruction of submarines, and finally, the invention of the atomic bomb; and in the hands of our enemies, the pilotless airplane, the so-called V-1 weapon, and long range rockets or the so-called V-2 weapon. The extent of destruction accomplished by these means is very vast indeed. The cities of Germany and Japan lie in nearly total ruin. Those of Russia, England, France and the Balkan countries suffered serious damage. Among the major combatants, only the United States escaped such destruction.

It is of interest to consider what could possibly be the future development in a possible Third World War. Such a war may start with atomic bombs, or it may start with other mass destruction weapons and finish with atomic bombs. It is almost certainly to be expected that the scientific foundations for other weapons of war will be discovered in the years ahead, and their development on a large scale will again occur in another World War. Of course, it is not clear as to how such a war would start, because of course we do not know what conditions may obtain at such a time; but just as World War I ended with the airplane and World War II started with it, so we may expect that World War III may start with the atomic bomb which was developed at the end of World War II. It is surely to be expected that such a war would again result in a vastly increased destruction over that which we have witnessed in this war. It is to be expected that all the large cities of all the industrialized countries of the world will lie in ruins at the end of such a conflict. This statement would probably be true even if the atomic bomb had never been invented, but the atomic bomb certainly dramatizes the situation and gives us perhaps a more realistic picture of what such a future war would do. One could only conclude that the chance of survival of our civilization would be small, and it is possible that even the survival of the dominant races of the earth would be in doubt.

Had the development of atomic energy occurred in peacetime, the development of peacetime uses would have been predominant, and the development of the atomic bomb might have been delayed until later. Had this occurred, it would be far more difficult to convince the people in regard to the danger of a future World War; and in this case, the world would almost certainly have drifted toward another conflict, with all the combatants securing atomic weapons at approximately the same time and using them against their enemies. There is just a possibility that because atomic weapons were developed in this war, and used only at the very end, we can use the spectacularly destructive character of these weapons to warn the peoples of the world in regard to the dangers of such another conflict. In this way, it may be that the development of these weapons during this war may be a positive benefit to the world. Those of us who contributed in one way or another to the solution of this weapon hope that our efforts may in fact in the long run contribute to the ultimate well-being of men, and not to their destruction.

It is well to review again some of the features of atomic bombs, for they present a compelling reason for the solution of political problems of greatest magnitude. The atomic b mb is a very great weapon,

even at its present stage of development. Recently the War Department has released detailed statistics on the destruction caused by a single bomb exploding over the Japanese city of Hiroshima, 78,150 persons were killed; 13,000 persons were missing, and 305,000 were casualties. Of 300 doctors in the city, 240 were casualties. Of 2400 nurses and hospital orderlies, 1800 were casualties. The General and his staff, stationed in the city, were all killed. Out of a garrison of 8,000, 5,000 were killed. 26 fire stations out of 33 were useless. All hospitals were useless. All buildings within a radius of one and a half miles were down, and something like half of the buildings at distances of 3 to 4 miles were wrecked. Fires burned uncontrolled for 10 hours.

These figures leave no doubt as to the destructive character of this bomb. It remains to state, however, that they can be made relatively cheaply and in relatively large numbers. Granting reasonable improvements in processes which are largely foreseen at the present time, these bombs probably could be made more cheaply than equivalent amounts of any other explosive known. They could be delivered by a variety of methods which we now know of, including airplanes, the V-2 weapon, as well as mining of our cities by enemy agents.

Scientific men who have worked on the atomic bomb state that they know of no defense against the atomic bomb, and they state categorically that none can ever be invented. This is a very broad statement, one which many will question, and there are two points of view in regard to this which I wish to present briefly. In the first place, we might consider detailed mechanisms by which these bombs might be delivered, and then attempt to devise methods to prevent their delivery. Such studies lead to the conclusion that it would be very difficult indeed to devise defensive measures that would be adequate, and lead to the conclusion that so far as present developments go, none could be devised that would meet the necessary tests for adequacy. In a more general way, we can see that if defenses against atomic bombs are no more effective than defenses against other types of weapons such as airplanes carrying ordinary bombs, submarines, machine guns, and other weapons, these new weapons will also be able to produce an amount of destruction commensurate with their capacities for destruction. It is to be expected that at least some of the atomic bombs, and perhaps a large fraction of all atomic bombs that are launched in the future, will arrive at their destinations, and produce a destruction of the order of magnitude or greater than that produced at Hiroshima. In this way, we may conclude that atomic bombs will destroy the industrial cities of the entire world, and probably do so in a very short time.

In another way, it is impossible to expect a defense against the atomic bomb. It is a saturation weapon. One single bomb dropping on a fair-sized city completely paralyzes all possible defensive methods that may be used against others which might be launched against that city. Statistics on Hiroshima again show that no adequate defense could possibly have been put up by that city against any further bombs being launched against it. In one single blow, all the natural resources of the population, and all its technical methods of defense are completely paralyzed. The V-1 weapon was a slow-flying plane which could easily be seen and which could be shot down by airplanes. This was all known before the weapon was first used against London. Yet in the first attack only some 10% of these bombs were shot down, and it was some 6 weeks before 95% were destroyed. Had they been loaded with atomic bombs, the city of London would have disappeared in a matter of minutes, and there would have been no opportunity to become proficient against the delivery of other bombs. The V-1 could then have been directed against another city, which would have suffered the same fate. Never, during the course of

the war did we succeed in intercepting a V-2 bomb. These traveled at a velocity higher than that of sound. They cannot be heard and they could not be seen even with the aid of radar. They arrived without warning, and had they been loaded with atomic bombs, the city of London would have disappeared without the people ever having realized that any weapon was being directed against the city until the blinding flash of atomic bombs appeared in the sky. There is no defense against the atomic bomb, and there never will be any defense. It is well to remember this in thinking of the possible solution of the problems of modern war.

Accepting these statements—and so far as I know, all the informed atomic scientists on the entire Manhattan Project accept them without question—it is necessary to review other methods for the defense of a country such as the United States, or any other large country of this kind, than those which have been considered in the past. The problem, in fact, moves beyond even the problems of major strategy of military forces. The problem moves into the realm of the fundamental organization of modern society, and the ultimate causes of armed conflict. But before going on to such questions, let us ask a few questions in regard to the possible uses of traditional methods of defense of a country such as our own. What means can a Navy use to prevent the effects of atomic bombs? How would a land Army prevent these effects, and what means could an Air Force exert to accomplish these same ends? These armed forces must develop means for intercepting airplanes, V-2 weapons, or perhaps other delivery vehicles from delivering their atomic bomb loads. One can imagine a large circle of defense far from the shores and boundaries of this country, which must keep up its vigilance night and day, year in and year out, against the possible undeclared attack of another country against ours. The tragic story of Pearl Harbor illustrates the difficulty of being constantly on the alert, even in a limited area, and leads us to the conclusion that such a constant alert over a long period of time could not possibly be maintained. Even if these various vehicles of delivery could be detected with certainty, the problem of complete, decisive interception of those weapons to a very high degree of effectiveness would be impossible on the basis of our experience in past wars. There is no military way to intercept the delivery of atomic bombs in adequate numbers to prevent the total destruction of the military effort of a country such as the United States.

We turn from the possibility of defense to the possibility of offense. The United States has the atomic bomb, is manufacturing them and storing them, according to the latest public information which we have. We may be able to produce a large stockpile of these bombs before any other country has them, and a possible method of solution of our problems is to attack. At that time, we probably could destroy the entire industrial potential of all the other industrial countries of the world, and prevent them from attacking the United States for some years to come. In order to prevent the development of atomic bombs by such conquered countries, it would then be necessary to police those countries, or perhaps to periodically destroy all their industries. The policing of the world by some 7% of its population is a very big problem indeed, and one which would convert this country from a peace-loving people to a nation of warriors, on a permanent basis. Such a solution would change our lives and those of our children for generations to come.

It is difficult for me to imagine that the people of the United States would choose such a course of their own free will. I am quite sure that this program can only be carried out by first destroying completely the democratic form of the government of the United States, and completely eliminating all of the freedoms which the people

of this country enjoy. It must be converted into a totalitarian, military machine of the type that ruled Germany from 1933 until the defeat of the country in World War II. Only in this way can we expect that the people of the United States could be induced to take on the onerous burden of such an aggressive war. We must remember that this might be done. This solution might be imposed upon the people of the United States if they do not watch from this moment on every tendency to destroy the liberties of our people. I reject this solution.

In the second place, there is the possibility of dependence upon strongly armed nations all around the world, all of us depending upon the threat of the destruction of future war to prevent anyone from undertaking such a war. This type of security has never worked in the past. Under these conditions, all the peoples of the world would live in constant fear of atomic bombs which might be delivered without warning from unknown enemies. There certainly could be no feeling of security in such a world. I am sure that all our traditional liberties will disappear under those conditions. Our country, down to the smallest hamlet and the most remote farm, will be an armed camp living under rigid military control. It seems to me that there is no solution to this problem except one where war is abandoned by all nations. In 1928, the Kellogg-Briand Pact attempted to outlaw war as an instrument of national policy. It was unsuccessful. The present situation requires that the ideals expressed in this Pact must succeed if we are to have any peace in the future. The only questions are, how shall this be accomplished? The problem is essentially a political one, and not at all a scientific one, and hence is a more proper one to be discussed by our political leaders. However, the scientific men who helped to produce the atomic bomb have exhausted all possible technical methods of solving this problem, and hence they must turn to fields which are strange to them, and in which they can claim no particular competence over their fellow citizens. The old adage says that need and fear are the mothers of invention. Need and fear are with us, to a degree never before experienced on such a vast scale in all of history. We of the scientific group are trying to bring home to our colleagues and our fellow citizens the intense fear that we have experienced for years. We have recognized for years that the product of our minds and hands would become the greatest threat to ourselves, our children and our fellow citizens.

Today, it seems inescapable that within a relatively short time a world government must be established if we are to avoid the major catastrophe of a Third World War. It seems that this must occur by one method or another, by conquest or by agreement. That it is difficult to accomplish this must be admitted by all of us, since there are so many divergent interests and points of view between the principal countries of the world. There is the great difficulty of the Communist and Capitalist systems, and the perhaps even greater difficulty of our different ideas in regard to personal freedom. There is also the great problem of the large disparity in education and economic well-being in the various parts of the world. But today, even oceans cannot be regarded as adequate barriers against the invader. It seems very doubtful indeed if in another world conflict this country can emerge with the small amount of destruction that we have experienced in this war; it seems nearly certain that as great or greater destruction as that of Europe in this war will be our lot.

Many proposals have been made in regard to accomplishing this end result of world government. There is the United Nations, where at least the difficulties arising between states are now for the first time discussed openly for all the world to note and hear, which is indeed an important step forward, for we at least have a

public debating society to help form public opinion. The United Nations as it is at present organized, however, cannot be regarded as a world government, for such a government must be expected to have sovereignty in certain limited fields, and it must have legislative, executive and judicial functions, none of which it possesses at the present time. This may be the beginning of complete disarmament of the nations of the world, as has been called for by Senator Tydings in a Resolution presented to the Senate. The complete disarmament of the nation-states and the reservation to the United Nations of the right to maintain a military force armed only with rifles, does not in itself solve the problem of a world government. There must be in addition to this an adequate organization for settling the disputes which arise between the states of the world.

But over and beyond all of these things, we must establish a consciousness on the part of all the peoples of the world that the old methods of settling disputes can no longer be used. Behind any government of any kind there must be the consent of the governed in a very real sense. The peoples of the world must have confidence in a world government and must believe that it will act justly and fairly with respect to their interests. This is a general statement of the solution to these problems. It is not easy to attain, but in these matters something of the genius which entered into the development of our modern industrial civilization and finally into the invention of the atomic bomb must be put to work if we are to survive in this modern world.

I have said little in regard to the peace uses of atomic energy because they are of little value unless the threat of the atomic bomb is exorcised. In fact the peace uses of anything else will be of short duration unless this problem of technological war is solved. But we can hardly secure all our motivation from negative incentives and therefore some discussion of the peacetime uses of this new energy should be presented.

We at this time do not know how great the industrial uses of atomic energy will be, and it seems probable that any estimate we make will be on the conservative side. Could anyone have foreseen the industrial development of steam, electricity, the radio, internal combustion engine, to mention only a few examples?

First of all let us consider the possibility of power from atomic energy. The present piles are generating large amounts of heat but at such low temperatures that it is useless for power purposes. Technically it is feasible to produce power at high temperatures though it is not possible at present to say that such power can be produced at such costs that it can compete with power from coal, oil, or water power. It is my expectation that it will be some time before power at such price levels can be secured because of the extensive development which must still be done. Such power plants so far as we can see will be very large because enormous amounts of radioactivity are produced in such piles and they must be shielded by thick concrete walls. Thus power plants will be large and massive and therefore can be used only for stationary power plants or for large ships. They present the possibility of smokeless power though the radioactive by-products must be disposed of in some manner.

These large amounts of radioactivity are now available for work on cancer. Progress on the control of this disease has been made during recent decades by a variety of methods including the use of radium. Further progress will be made because of the inexpensive radioactive substitutes for radium that are now available.

Atomic energy plants also produce large quantities of radioactive tracers which are research tools of the greatest importance. In the future our metals, plastics, and other materials of construction will be better because of the use of atomic energy by-products in our studies.

At the present time there is a great tendency to justify science on the basis of its practical utility—a tendency which I wish to protest. The greatest accomplishment of the Manhattan Project was neither the production of the atomic bomb, which is wholly evil, or the possible peacetime industrial use of atomic energy. The great accomplishment, in which all scientists who worked on this project take great pride, was the unlocking of nature's secrets and the production of events which probably never took place anywhere else in all the universes of the heavens. Nuclear chain reactions of the controlled kind or of the explosive kind are probably novelties of this earth and do not occur anywhere in the billions of stars of the milky way unless some other particle of dust such as our earth is inhabited by intelligent beings such as ourselves. Science, literature, art and all the intellectual pursuits of man are particularly those of our species. It is these of which we are all proud. It is the contribution to these things of which scientists of the atomic bomb project are proud. We ask your help and offer ours to you for a united effort toward making this a safe and secure world in which man's constructive genius in all lines of human endeavor may expand. We ask your help and offer ours to the end that the destructive uses of science shall not destroy its constructive uses and all else of value in this civilization.

USING DEMONSTRATIONS FOR PROVIDING PUPIL EXPERIENCES IN THINKING

G. P. CAHOON
Ohio State University

UNFORTUNATELY, a tendency and ability to think scientifically is not a necessary nor automatic outcome achieved by pupils in science classes. It is not an "either-or" case, however—*either* teach science facts and principles *or* critical, reflective, scientific thinking. The demonstrations, laboratory experiments, directed studies, pupil projects, motion pictures, textbook statements and pupil-teacher discussions are teeming with possibilities for pupil experiences in thinking. It is largely a matter of utilizing these appropriately as one goes about teaching science facts and principles to pupils. One cannot satisfactorily achieve these objectives by having a unit for two or three weeks on "scientific method" somewhere in the general science, biology, chemistry, or physics course and then concentrate on the "facts" for the rest of the year. Indeed, if a mastery of facts is the important course outcome, its realization may be often furthered by appropriate experiences in thinking. The emphasis which good science teachers have for years placed upon the "why," "what-would-happen-if," "explain," "give examples" type of question is illustrative of a simple technique in this area.

Like any other teaching aid or pupil activity, a particular exercise or experience in thinking may or may not be appropriate to use with a particular class at a given time. A certain demonstration for one class may be given to help obtain a particular fact of science, at another time as an experience in accurate observation, at another to utilize previous knowledge for predicting "what will happen," at another as an application of a recently studied principle.

The following examples have been used in physics, chemistry, or physical science classes with tenth, eleventh, or twelfth grade pupils. They are illustrative of one

quite satisfactory way of using demonstrations to emphasize thinking; they have also proved interesting to pupils.

1. Crushing of tin can

General procedure: A little water is placed in the bottom of a can such as a varnish can. A cork is provided so that it snugly fits the opening in the can and can be quickly and tightly inserted. The can with the water is heated until the water is boiling and steam is escaping from the opening in the can. The cork is inserted tightly, and the source of heat immediately removed. The can is set aside and allowed to cool in the air or placed in a large pan or in the sink, and cold water poured over it. As it cools the sides are crushed in.

Presentation to and Discussion with Class (11th or 12th grade pupils): For use with the following questions, this demonstration has been presented by telling the pupils that their attention will be called to the important things which are done in the demonstration and to the things which happen, although both of these will be quite evident. It is suggested, however, that it will not be explained why they are done that way nor why what occurs should happen—that they will be expected to be thinking about the "why" and to answer the questions below in class after the completion of the demonstration. Some of the points which have been stressed or called to the attention of the class as the demonstration proceeds include:

The small amount of water in the can;
That the water is heated to boiling—notice steam escaping;
The cork put in while steam is escaping;
Source of heat removed immediately after cork is in;
Manner of cooling the can;
The "cave-in."

Questions on Demonstration (For use with 11th or 12th grade pupils)

(1) Just what does this demonstration really show?
What can you conclude from it?
(2) List the important things which you actually observed or saw happen—those things which would need to be mentioned in explaining what happened.
(3) Indicate some of the things which you assumed or took for granted—things which would be necessary in explaining what happened.
(4) Show how the points which you indicated that you actually observed and those which you assumed helped you to arrive at your conclusions (in (1)).
(5) Why was the source of heat taken away immediately after the cork was put in?
(6) What was the purpose of boiling the water?
(7) Indicate one or two other ways in which the purpose for which the water was boiled could have been accomplished.
(8) Why doesn't the gasoline tank in the rear of an automobile collapse in a similar way when a full tank of gas has been used?

2. Magnetic Effect of an Electric Current

General procedure: A storage battery is connected in series with a tap switch, flexible wire, and suitable resistance so that 5 or 10 amperes will flow through the wire. The wire is arranged so that it can be placed first just above and then just below a compass needle, extending parallel to the N-S direction of the needle. When the switch is closed with the wire above the compass, the needle turns to a right angle to the wire; when the switch is closed with the wire below the needle, it turns to a right angle in the opposite direction. When the switch is open the needle returns to its normal N-S direction.

Presentation to and Discussion with Class (11th or 12th grade pupils): The following is one way in which this has been presented to a class which has had experiences with and knows the simple facts of elemetary magnetism, and is just

starting work with electro-magnetism. The teacher has suggested that he would like to see just what meaning the class gets out of a rather simple but very fundamental demonstration. Accordingly he will perform the demonstration without comment, and ask the pupils to give their reactions to a few questions relative to the demonstration immediately after it is finished. Care is taken, of course, that all pupils can see just what is happening. The circuit is explained so that pupils understand that when the key is pressed a current flows through the wire. (A large compass needle, with the N pole clearly marked, perhaps by a rider of paper, is desirable. The lighting should be such that all pupils can observe clearly. For use with the following questions the polarity of the wires to the storage battery should not be reversed).

Questions on Demonstration (11th and 12th grade pupils. Taken from answers which pupils gave).

a. Indicate by a check or cross which of the statements below are justified on the basis of this demonstration.

..... (1) Electricity is magnetism.
..... (2) A stronger current will produce greater magnetism.
..... (3) The wire carrying the current is magnetized.
..... (4) The same magnetic effect is produced anywhere along the wire.
..... (5) A current-carrying wire produces a magnetic effect.
..... (6) An electric current is magnetized.
..... (7) Reversing the poles would reverse the direction in which the needle would turn.
..... (8) In a current carrying wire a magnetic field is produced which is in concentric circles around the wire.
..... (9) The current is opposite in direction above the needle to that when below the needle.
..... (10) This demonstration (or experiment) is known as Oersted's experiment.
..... (11) Magnetism always acts at right angles to the electric current producing it.
..... (12) Magnetism can produce electricity.
..... (13) One end of the wire is an N pole, and the other an S pole.
..... (14) Magnets can only be made by electricity.
..... (15) The electricity was the cause of the magnetism.
..... (16) This is the principle of the electric motor.
..... (17) Copper wire does not retain its magnetism, as does iron.
..... (18) Magnetism cannot be separated from an electric current; i.e., it always is present if a current is flowing.
..... (19) The magnetic field around a current carrying wire is similar in shape to that of an ordinary magnet.
..... (20) The magnetic force is in an opposite direction above the wire to that below the wire.

b. The following statements are possible applications of the principle illustrated in the above experiment. Indicate by a + or O those which you think would or would not actually occur or hold true, and in the space underneath give your reasons for each, whether + or O.

..... (1) The compass needle would behave the same way if the lamp bank were plugged into the ordinary house circuit instead of using a storage battery.
..... (2) A compass needle held under an N-S trolley wire would point E-W.
..... (3) If a strong enough current is sent through a wire, iron filings or brads should cling to it.

3. Production of Current by electro-magnetic induction

General procedure:

a. The ends of a coil of insulated wire (such as bell wire or smaller) are attached to the terminals of a sensitive demonstration galvanometer. The coil has about 25 turns and is approximately two inches in diameter. A bar magnet, or one pole of a horseshoe magnet, is thrust through the coil and then pulled out. The magnet is then kept stationary and the coil thrust over it, and removed. The poles of the magnet are reversed, and the operation repeated.

b. The coil is replaced with the secondary of the typical upright electromagnetic demonstration apparatus, and the above operations repeated.

c. The primary of the electromagnetic demonstration apparatus is used instead of the magnet. This is connected to a dry

cell or two and used both with and without the iron core, the same operations as in (a) being performed.

d. With the secondary in place inside the primary, and both remaining stationary, the primary circuit is alternately opened and closed.

Presentation to and Discussion with class: This has been presented to the class in a manner somewhat similar to the preceding demonstration. New terms or concepts, such as primary and secondary, were explained. Pupils were told that they would not have pointed out to them the important things to observe, nor what the demonstration showed or illustrated—that they would be asked concerning these at the end of the demonstration. They are allowed, and even encouraged, to take what notes they desire during the demonstration.

Care is taken that all pupils really see what happens. When a large demonstration galvanometer is not available it has been possible to project an image of the galvanometer needle on the screen. Pupils are allowed to sit or stand where they can see.

After pupils have attempted to answer the questions, differences of opinions and observations about which they are not sure will often make it desirable to repeat some or all of the parts of this demonstration, with further discussion.

Questions on electro-magnetic induction demonstration

a. List the important points which you observed that were brought out by this demonstration—just those things which you saw actually happen. These might be thought of as the data or results or observations of the experiment or demonstration.

b. Indicate by a check mark of the statements below you think are valid or true as conclusions to be drawn from the results or observations of this demonstration.

..... (1) The stronger the magnet, the more current is produced.
..... (2) An electric current can be produced without batteries or generators (dynamos).
..... (3) A magnet placed in a coil will produce an electric current.
..... (4) The amount of current produced depends upon the speed with which the magnet moves through the coil.
..... (5) The magnetic field of the horseshoe magnet is stronger than that of the electro magnet.
..... (6) Making and breaking any circuit produces an electric current.
..... (7) The second coil is the one with the most turns of wire.
..... (8) A current is produced only when the magnet moves into or out of the coil.
..... (9) The current produced by a magnet entering into a coil is opposite to that produced as it returns from the coil.
..... (10) When there is no motion of the magnetic field relative to the coil, no current is produced.
..... (11) Lines of force have to be cut by, or thread through, wires or conductors in order to have a current produced.
..... (12) An induced current is not as strong as current produced chemically, as from a dry cell or storage battery.
..... (13) A current is produced in the secondary coil as long as current is flowing in the primary coil.
..... (14) An alternating current cannot be produced by induction.
..... (15) The current in the secondary coil is always larger (stronger) than that in the primary coil.
..... (16) The current in the secondary coil is the induced current.

4. Plant Food in Soil

General procedure: A lamp chimney has one end covered with cheesecloth, to hold the sand and soil which is placed nearly to the top of the chimney—about ⅓ sand at the bottom and remaining soil at the top. Tap water is poured in, and the water which comes through is caught in a beaker beneath. Some of this water is evaporated in a watch glass and examined for a residue.

Presentation to and discussion with class (8th, 9th, 10th grade general science or biology)

This was once presented in the following way. It was suggested to the class that one of the members (Paul) had read in

a book of a way of proving that "minerals which are essential for plant growth are dissolved by water from any soil;" that Paul had set up this apparatus and would demonstrate this to the class. The teacher further suggested that he was going to ask them for their reactions after the demonstration as to whether they were convinced that Paul had proved this to them.

Paul went through his demonstration without much comment, simply saying that the sand was to act as a filter to hold back the larger particles of soil in the muddy water. He showed a white deposit on the watch glass, which he said "proved that there were in the soil minerals, necessary for plant growth, which are dissolved by water."

Questions (8th, 9th, 10th grade pupils)

a. One type used

List the assumptions which you would have to make—that is, the things you would need to take for granted—in order to agree that Paul's statement is proven.

b. Alternate questions

Another way has included a list of possible assumptions taken from those which pupils had made in response to such a question as above (4a). The pupils have checked those necessary in order that the demonstration "prove" the statement. Such a list follows:

Check which of the following you think would have to be assumed, or taken for granted, in order that Paul's statement be proved.

..... (1) The sand does not contain minerals.
..... (2) The soil contains minerals.
..... (3) The tap water does not contain dissolved minerals.
..... (4) The minerals will dissolve in water.
..... (5) The minerals will dissolve in water in the time that it takes the water to filter through.
..... (6) The minerals do not evaporate with the water.
..... (7) The soil used is typical of (like) any soil.
..... (8) Plants need oxygen for growing.
..... (9) The soil contained no water before the water in the demonstration was added.
..... (10) The residue is mineral.
..... (11) The watch glass was clean.
..... (12) The beaker was clean.
..... (13) The lamp chimney was clean.
..... (14) The sand does not filter out (hold back) the dissolved minerals with the soil particles.
..... (15) Muddy water does not contain minerals.
..... (16) The residue is essential for plant growth.

c. Which of the above statements that you have marked as assumptions do you think so important for proving that "minerals are dissolved by water from any soil" that something should have been done to show that these assumptions were really true? Indicate these by encircling the proper number.

d. Suggest something which you think could have been done for each of the statements (assumptions) which you encircled (in 4c).

e. What do you think this demonstration really shows? Why?

5. Hydrochloric Acid Fountain

General procedure: A flask is filled with HCl gas by downward displacement in the usual way. A single-hole stopper is fitted with a glass tube to extend into the flask. A rubber tube is attached to the glass tube to extend a short distance outside the flask. The rubber tube may be provided with a pinch clamp, or may be closed and opened by pinching with the finger. As soon as the flask is filled with gas, the tube and stopper are inserted. The flask is inverted and the closed end of the rubber tube placed in water in a beaker or other container. When the end of the rubber tube is opened under the water, the water will rise into the flask forming a fountain. A small amount of blue litmus solution is placed in the lower beaker so that the fountain becomes red.

Presentation to and discussion with class (10th, 11th, 12th grade)

With questions such as those which follow to give pupils experience in apply-

ing facts and principles to a new situation and in predicting, this interesting demonstration has been simply shown to the class, with the request that they answer the questions. Of course, it is made evident to pupils what is done in setting up and starting the demonstration, and the whole so arranged that they can see it operating.

Questions:

(1) If the flask was full of HCl gas, what causes the water to start to rise in the tube?

(2) As the first few drops of water enters the flask, what happens?

(3) Why doesn't the fountain continue indefinitely as long as there is a supply of water in the beaker?

(4) Where should the end of the glass tube be located, near the top of the inverted flask, toward the middle, or down into the neck, or doesn't it make any difference? Why is this?

(5) Why should the blue colored water become red in the fountain?

(6) What property of HCl gas is illustrated in the question and answer to No. 1?, 2?, 3?

(7) Which of these illustrate physical and which chemical properties?

(8) If a piece of dry, red litmus paper were placed in the flask of HCl gas before the fountain were started, what change would you predict should take place? Why?

(9) If the HCl gas had been compressed into the flask, so that the flask contained, say, twice as much as in the previous demonstration, what do you think would happen if the same procedure were followed? Indicate your prediction and reasons why you think this would happen, then try it out. If when you try it, the results are different, can you give the reason for what did happen?

ORGANIZATION OF A BASIC SCIENCE COURSE

W. C. VAN DEVENTER
Stephens College, Columbia, Missouri

I. Trends in Science Survey Courses

Science teaching has changed progressively in the direction of greater attention to individual and social needs. The survey course has contributed to this change. Havighurst (1) has defined a survey course as "any course intended for college freshmen and sophomores primarily as a part of their general education, which draws its subject matter from two or more of the ordinary college departments." He classifies science survey courses by using three pairs of characteristics: "Pure science" or "interpretive," "comprehensive" or "selective," and "analytical" or "descriptive." Powers (1) distinguishes two general types of organization, a "special-fields" emphasis, in which the various science subjects are treated as distinct units, and a "broad-fields" emphasis, which is organized around broad generalizations, and attempts to integrate related subject-matter areas. Charters (1) classifies survey courses as "terminal" or "exploratory," "spectator" or "participant," and "mosaic" or "integrated." While these categories of classification overlap, they indicate the directions in which variation has taken place.

During the last ten years the course in general biology at Stephens College has been developed as a science survey course. It is a man-centered course in functional science. Under Havighurst's classification it is "interpretive," "selective," and more "analytical" than "descriptive." Under Powers' two categories, it has a "broad-fields" rather than a "special-fields" emphasis. In regard to the characteristics listed by Charters, it is an "integrated" course, "terminal" for most students, and one in which students are "participants" rather than "spectators."

In an introductory course for laymen it is necessary to relate the facts and principles of science to the needs and interests of students. There are two approaches to this problem. One is to teach facts and principles in an organized manner, and allow students to make their own applications to problems of living. The other is to locate important needs and problems, and teach those facts and principles which are related

to them. The second approach has been adopted at Stephens.

Since man is a living organism, human problems are deeply rooted in the biological area. Therefore in dealing with these problems, much biological material is included. Materials from other sciences are necessary, as well as from social science, philosophy and esthetics. The criterion of what to include lies in the nature of the problems and not in any desire or necessity to cover subject matter or survey particular fields. Actually, the biological field is well surveyed, and much material from the physical and social sciences is included. This coverage, however, is strictly incidental to the goals of the course.

II. Selection of Subject Matter

A consideration of human problems involves primarily present and future aspects. It involves the past or historical aspect only incidentally. Therefore any attempt to find a basis for selection of subject matter must concentrate on methods for discovering those topics most significant now and in the reasonably predictable future.

In initiating a research program* on which to base the selection of subject matter, it appeared that a careful study of science materials published over a period of years in various types of periodicals designed for laymen would furnish an objective basis for ascertaining present and persisting science needs. While such a study does not constitute an exhaustive survey, it serves as an indicator in much the same fashion that certain species of plants and animals serve as indicators of entire biotic communities in ecology, and certain kinds of fossils serve as indicators of geological periods. It helps also to form a basis for determining probable future science needs. Not only does non-technical periodical literature indicate topics of sustained and continuing importance, but its very nature causes it to be sensitive to those phases of science which are most significant for the future. Also through the medium of news content as well as advertising, non-technical periodicals are constantly helping to create future science needs. Therefore a study of non-technical periodicals indicates the frontiers of research where science is alive and growing, and where new needs are most likely to develop.

The *Scientific Monthly* was selected as a periodical for the general scientific reader, and was surveyed for a period of ten years. *Time* was selected as a periodical for the intelligent layman, and was surveyed for a period of five years. The *Ladies' Home Journal* was selected as a periodical read by the average woman, and was surveyed also for five years. The years studied were chosen so that both pre-war and war periods were represented.

Not only complete articles but parts of articles and informational advertisements were included. Other studies of this nature have involved measurements and calculations of percentages of space occupied. In this investigation only the relative number of occurrences was considered significant. A science article was credited in more than one category if its contents included materials in more than one area. Thus an article might be credited under "Animals and Plants" and also under "Food" if it dealt with animals and plants used as food.

The data from the periodicals was classifiable under a limited number of topics. The method followed involved starting with a much larger number of topics (206) and combining and grouping them until a smaller number were obtained which proved adequate to classify material from all sources. The list became progressively

* The writer wishes to express appreciation to Dr. W. W. Charters, Dean B. L. Johnson, Dean W. P. Shofstall and Dr. C. N. Rexroad of Stephens College, Dr. S. R. Powers of Teachers College, Columbia University, Mr. Edward K. Weaver of Alabama State Teachers College, Dr. Philip N. Powers of Washington, D. C., and Dr. James Sanders of the University of Missouri for advice and encouragement in connection with this work.

more stable as the study proceeded, until finally no more changes needed to be made.

The following thirty-two topics were obtained: (1) Animals and plants, (2) Organism and environment, (3) Food, (4) Conservation of natural resources, (5) Human geography, (6) Biological aspects of housing, (7) Weather and climate, (8) Body form and function, (9) Embryonic development, (10) Heredity, (11) Personal appearance, (12) Health and disease, (13) Nature of matter, (14) Uses of materials, (15) Fuels and energy, (16) Drugs, (17) Radiations, (18) Methods of communication, (19) Tools and machines, (20) Methods of transportation, (21) Nature of the universe, (22) The earth, (23) Evolution and natural selection, (24) Evolution of man, (25) Races of man, (26) Population problems, (27) Behavior, (28) History of science, (29) Mathematics and life, (30) Science and philosophy, (31) Science and social problems, (32) Science and esthetics.

There were some differences in the relative prominence of different topics in the three periodicals. In the combined data, however, five of the thirty-two topics were outstanding. These were: Animals and plants, food, body form and function, health and disease, and uses of materials. In addition there were two somewhat diffuse areas, one centering around tools and machines, methods of communication, and methods of transportation, and the other around science and philosophy, and science and social problems.

In order to check the results of the periodical study, an analysis was made of student judgments obtained over a period of a year. These consisted of the topics which students selected for projects, in which they were allowed to work on anything significant for them in science or science-related fields. These data were analyzed on the basis of the thirty-two categories obtained from the periodicals. The results were remarkably similar. The same five topics were found to be outstanding, and there were two other diffuse areas, one including embryonic development and heredity, and the other centering around nature of the universe, evolution, races of man and behavior.

On the basis of these studies, the following eight subject-matter areas were set up:

A. Animals and plants
B. Food
C. Body form and function
D. Reproduction and development
E. Health and disease
F. Man's activities
G. Man's uses of materials
H. Science and man's thinking

These results correspond very closely with those of similar studies. Nearly all show a similar preponderance of biological materials over physical, and a similar emphasis on health, human biology, animals and plants, and food in the biological area, and materials and mechanical processes in the physical area. Finley and Caldwell (1923) (2) list health, animals, plants and food as most prominent in their study. Hopkins (1925) (4) says that "biological material occupied on the average four times as much space as physical, and ten times as much as chemical." He lists as most important for biology: Public health, knowledge of animal and plant life, foods, natural resources and evolution. For physics he lists appliances, tools, machines and construction. For chemistry he lists household processes, fertilizers and other materials. Hill (1930) (6) lists health, eugenics and food as most prominent.

More recent studies have yielded similar results. Newland (1937) (7) lists health, food elements related to health, and household appliances. DeLoach (1940) (8) found a definite preponderance of biological materials, with emphasis on health and animal biology. Novak (1942) found a very slight preponderance of biological materials which he classified under the headings of health and medicine, animal life, man and behavior, gardening and agriculture, conservation, and plant life. Martin

(1945) (12) in his general summary of researches of this type concludes that "Biology is the most common branch of science occurring in the representative newspapers and magazines selected for examination in the studies", and lists as the most prominent biological topics running through all of the studies: Human biology, health and disease, animal biology, foods and nutrition, and plant biology.

In considering the results of these studies, carried on under different conditions and using varying methods, the conclusion seems inescapable that we are dealing with a relatively constant factor in the field of human interests and needs, and that therefore this furnishes us a very solid basis for determining the content of a functional, man-centered science course, oriented toward the present and the future.

III. Problem Areas and Their Application

In this study the projects selected by students and the general character of material in the periodicals indicated that the average person is less concerned with scientific knowledge for its own sake than he is with science as a part of man's environment. Therefore the eight subject-matter areas indicated by the study may best be treated as phases of human ecology, or the relationship of man to his environment in the broadest sense. Human ecology consists of three major subdivisions:

I. Man in relation to the living world
II. Man in relation to the things that he uses
III. Man in relation to the ideas that shape his actions

If we consider the eight areas as phases of human ecology which contribute to these, we have the following organization:

I. Man in relation to the living world
  A. Animals and plants
  B. Food
  C. Body form and function
  D. Reproduction and development
  E. Health and disease
II. Man in relation to the things that he uses
  A. Man's activities
  B. Man's uses of materials
III. Man in relation to the ideas that shape his actions
  A. Science and man's thinking

Although in organizing the general biology course the selection of subject matter is of primary importance, in its presentation the course is intended to be problem-centered. As a result of experience in dealing with students over a period of years, the following four problem areas seem to be outstanding:

1. Personal and behavior problems
2. Family problems
3. Community and social problems
4. Intellectual and esthetic problems

In order, therefore, to determine the most significant materials within the eight subject-matter areas, it is necessary to analyze each one in terms of these four problem areas. In this way the problem areas become contributing subdivisions. The following sample indicates the method used in this analysis:

I. Man in relation to the living world
  A. Animals and Plants
    1. Personal and behavior problems in relation to animals and plants
    2. Family problems in relation to animals and plants
    3. Community and social problems in relation to animals and plants
    4. Intellectual and esthetic problems in relation to animals and plants
  B. Food
    1. Personal and behavior problems in relation to food
    2. Family problems in relation to food

3. Community and social problems in relation to food
4. Intellectual and esthetic problems in relation to food

Thus there are thirty-two subdivisions, each consisting of a problem area in relation to a subject-matter area. Each of these requires further analysis. The questions which come from the students constitute points of attack. These arise ideally in connection with actual teaching situations, but on the basis of past experience some can be anticipated. By utilizing them, student experiences, consisting of either group or individual work, can be planned. In the student manual each subdivision is implemented by lists of problem-questions and related activities. This breakdown is necessarily incomplete, and must be supplemented by additional questions and ideas for experiences suggested by students.

One of these subdivisions is included here as an example:

I.B.1. Personal and behavior problems in relation to food

Problem-questions:

What foods do I need?
Do I need to lose or gain weight?
How may I lose weight without injuring my health?
What happens to the food that I eat?

Activities:

Project topics:

1. Food requirements of the body
2. Vitamins
3. Minerals needed by the body
4. Normal weight in relation to health
5. Dieting to lose or gain weight
6. Keeping a diet record
7. Maintenance systems: Digestion, circulation, respiration and excretion.

Group experiences:

1. Motion pictures on food requirements
2. Motion pictures on maintenance systems
3. Dissection-demonstration of maintenance systems in laboratory animals
4. Diet experiments with rats
5. Discussion groups on food requirements, and losing and gaining weight.

With this organization the course comes to consist of the treatment of real problems, grouped in the four categories indicated by work with students, and organized under the eight subject-matter areas. Teachers may raise the question of whether a course of this kind will include the facts and principles of importance to the scientist. In attempting to answer this question, a list of significant facts and principles was prepared, based on experience with standard courses, consultation with colleagues and perusal of textbooks. All of the facts and principles on which there was general agreement are included in the course. Some additional topics are also included, and the traditional material is dealt with from a different point of view, since it is related directly to problems of living. This serves to increase motivation and promote student effort.

IV. Summary

1. The general biology course which has been described is a survey course of the "interpretive", "selective", "analytical" and "integrated" type. It is "broad- fields" in emphasis, and "terminal" in character.

2. In orienting the course toward present and future needs, a research study was undertaken which included an analysis of science materials in representative periodicals and student selections of activities.

3. As a result of this study eight subject-matter areas were selected: Animals and plants, food, body form and function, man's activities, man's uses of materials, and science and man's thinking. These were considered to be aspects of man's relation to his environment.

4. Student problems, classifiable as personal and behavior problems, family prob-

lems, community and social problems, and intellectual and esthetic problems, furnished a means of analysis by which the eight areas could be used in teaching.

5. A program of instruction, consisting of projects and group experiences, chosen on the basis of individual interests and needs, was organized.

6. This course was found to contain the facts and principles ordinarily included in a general biology course of standard type, together with much additional material.

BIBLIOGRAPHY

1. Johnson, B. L. (Editor). *What About Survey Courses?* New York: Henry Holt and Company, 1937.
2. Finley, C. W. and Caldwell, O. W. *Biology in the Public Press.* New York: Lincoln School of Teachers College, Columbia University, 1923.
3. Curtis, F. D. *Some Values Derived from Extensive Reading of General Science.* Contributions to Education No. 163. New York: Bureau of Publications, Teachers College, Columbia University, 1924.
4. Hopkins, L. T. *A Study of Magazine and Newspaper Articles with Relation to Courses in Science for High Schools.* School Science and Mathematics 25:793–800, November 1925.
5. Searle, A. M., and Ruch, G. M. *A Study of Science Articles in Magazines.* School Science and Mathematics 26:389–396, April 1926.
6. Hill, H. A. *A Comparison Between the Biological Content of Certain Periodical Literature and the Kansas High School Course of Study.* Science Education 14: 430–436, January 1930.
7. Newland, E. *A Study of Allusions to Science in Magazines.* Science Education 21: 126–130, October 1937.
8. De Loach, W. S. *The Scientific Articles in a Popular Magazine.* Science Education 25:273, October 1941.
9. Novak, B. J. *Science in the Newspaper.* Science Education 26:138–143, October-November 1942.
10. Martin, W. E. *A Demonstration of the Principles of the Biological Sciences of Importance for General Education I.* Science Education 29:100–105, March 1945.
11. *Ibid., A Demonstration of the Principles of the Biological Sciences of Importance for General Education II.* Science Education 29:152–163, April–May 1945.
12. *Ibid., A Chronological Survey of Published Research Studies Relating to Biological Materials in Newspapers and Magazines.* School Science and Mathematics 45:543–550, June 1945.

ALCOHOL: What It Does for Man; What It Does to Man

H. B. HAAG

Medical College of Virginia, Richmond, Virginia

"An ounce of prevention is worth a pound of cure." This old saying applies both to occasional drunkenness and to chronic addiction to alcoholic beverages. The facts briefly stated on the following pages are the findings of science,* hence not colored by propaganda. A clear understanding of the known facts about alcohol and man should aid the individual and society in the search for the path of sobriety for all the people.

I. Why do people drink alcoholic beverages?

Beverages made of widely different ingredients, but all containing the common component alcohol, have been used by man in practically all climes and countries since the dawn of human history. What properties do such beverages possess which have made their use so widespread?

There are unquestionably those who delight in the taste of certain alcoholic beverages and use them primarily because of this taste. Such seems to be the case,

* The reader will find more extensive reliable information in the following books:

1. Haggard, Howard W., and Jellinek, E. M. Alcohol Explored. New York: Doubleday, Doran and Company, 1942.
2. Strecker, Edward A., and Chambers, Frances T. Alcohol, One Man's Meat. New York: The Macmillan Company, 1938.
3. Newman, Henry W. Acute Alcoholic Intoxication. Stanford University, Stanford University Press, 1941.
4. Waddell, J. A., and Haag, H. B. Alcohol in Moderation and Excess. Richmond, Va.: William Byrd Press, 1940.

especially for low alcohol preparations, such as some wines and beers. There are others who drink alcoholic beverages as part of a ritual or a social custom, and regard it as little or nothing more. Were it not, however, for the specific effect of alcohol on the brain, the number of people who indulge in alcoholic beverages would probably be negligible. Most people use these beverages because of the ability of alcohol to produce an initial and temporary feeling of well being, relief from fatigue, and relief from the cares, worries, boredom and restraints which harass so many of us in everyday life. These effects of alcohol induce a feeling of pleasant relaxation (euphoria). Naturally, under such mental conditions social duties seem to require less effort and become more appealing and pleasant. This is probably the main reason for the prevalence of the custom of serving alcoholic beverages at social functions.

II. How much alcohol can the average *normal* person drink without becoming drunk?

Normal individuals vary markedly in their tolerance to alcohol. As a matter of fact, the same individual may show great differences at different times. It is difficult to explain the differences noted between persons, but similar differences hold in the case of most drugs. The person's body weight is undoubtedly one important factor.

There are some general factors which can appreciably alter the speed and intensity with which the effects of alcohol come on in any given individual. One of these is the speed of drinking. The quicker the beverage is consumed the faster is the onset of alcohol action and the stronger the alcohol effect. A highball consumed in ten minutes is much more noticeably effective than it is when sipped over a period of an hour. This difference is due largely to the fact that when the rate of consumption is low the rate of alcohol destruction by the body tends to keep up with the amount being absorbed into the blood stream. The more diluted the alcohol is when taken, the slower is its rate of absorption from the stomach and intestines, and so the slower and less intense the effects. Hence, partly because of this, an ounce of alcohol taken as straight whisky has much more effect than the same amount of alcohol taken as beer. The presence of food in the stomach and intestines diminishes the rate of alcohol absorption and so its speed and intensity of action. Finally, alcohol taken when the sugar in the blood is low, as is usually the case several hours after the last meal, produces a greater action.

The acute effects of alcohol on the body are roughly proportional to the concentration of alcohol in the blood (and hence in the brain) at any one time. One bottle of beer (12 ounces) or one ounce of whisky brings about a 0.015% blood alcohol level in the average adult, as determined chemically. Up to a blood alcohol concentration of about 0.05%, control by the individual over his actions is not as a rule appreciably affected, the dominant effect being a state of mild euphoria. The average normal adult with that much alcohol in the blood is still sober. Experiments show that with a blood alcohol level of about 0.05% a critical concentration is reached, because beyond this point the person's control over his mental and physical activities may be definitely and seriously decreased. In the machine era in which we live this dangerous blood alcohol concentration is especially significant in relation to the operation of potentially hazardous machines, and most notably the automobile.

No entirely satisfactory definition has been so far agreed on for the term "drunk" or the condition of drunkenness. In some states the finding of a blood level of 0.15% alcohol renders a person drunk from the legal point of view. Blood alcohol concentrations up to 0.05% are regarded as indicative of sobriety. Fundamentally, the term "drunk" represents that stage of blood alcohol concentration where a person's normal control over his physical and mental activities is definitely decreased.

A single dose of alcohol is usually com-

pletely absorbed from the stomach and intestines in about 2½ hours. The peak of alcohol concentration in the blood is reached in about 1½ hours. After the alcohol gets into the blood it is destroyed and excreted at a rate equivalent to about the amount of alcohol in one bottle of beer or ¾ ounce of whisky per hour.

III. Who should completely avoid alcoholic beverages?

There are a number of persons who for one reason or another should avoid the use of alcoholic beverages. Uppermost in this class are those suffering from alcoholic addiction (habituation). Alcohol addicts who really want to get rid of this affliction can usually do so by the aid of modern medicine, but, according to present evidence, few, if any, alcohol addicts are ever "cured" of this affliction in the sense that they can again become "moderate drinkers".

Alcohol should be very definitely avoided by those who feel an increasing dependence on it for their contentment or happiness. As a matter of fact it is from this group that the real alcohol addict evolves, if the use of alcohol is persisted in.

Because of the rather specific action of alcohol on the brain, those suffering from many types of nervous diseases are likely to be made worse by alcohol. Notably is this the case in such disturbances as epilepsy and manic-depressive states.

Diseased conditions of the stomach and intestines, particularly those characterized by ulcerations and increased acidity forbid the use of alcohol because alcohol renders these conditions worse.

Individuals who because of inadequate diets have developed nutritional disorders, such as a vitamin deficiency, for instance, are apt to be unduly injured by alcohol. Proof of the importance of this is seen in experiments on animals maintained on deficient diets; these develop liver damage from alcohol under conditions where practically no effect is noted in animals on normal diets.

It is well to bear in mind that only under very special circumstances is alcohol today regarded or used by the medical profession as a medicine.

IV. What happens to alcohol in the body?

Alcohol requires no digestion prior to its absorption from the stomach and intestines into the blood stream. The blood carries the alcohol to the liver and this organ burns up to 95% of it, with the formation of water and carbon dioxide. Small traces of alcohol are eliminated as such by the exhaled air, and in the urine. For each 15 grams of alcohol (equivalent to somewhat more than an ounce of whisky) burned, 100 units or calories of heat are liberated. Alcohol is not stored in the body or converted into storageable compounds. It may substitute, as a source of energy, for certain foods, especially starch and sugar. Although alcohol in the body can yield calories or energy, alcoholic beverages are by no means complete foods; for one thing, they are practically devoid (except beer) of proteins and vitamins.

Alcohol is not essential for normal health, physical or mental. Actually it is a potential injurer of physical and mental efficiency.

The most important and immediate effect of alcohol is to depress, and not, as popularly believed, to stimulate, the brain. Its initial and most powerful action is to depress those areas of the brain having to do with judgment, self criticism and self restraint. As a result of this depression, the normal "brakes" on the words we utter and the deeds we do are eased. Freed of normal restraints, our actions give the impression of a stimulating effect from alcohol.

At alcohol blood levels up to 0.05% the depression is rather mild and tends to produce or promote the sense of well being previously described.

Above this concentration there may be marked and immediate impairment in the normal functioning of the nervous system, and constant (chronic) exposure of the

brain to high blood alcohol levels may lead to serious mental disturbances such as alcoholic psychosis, including alcoholic hallucinosis, and delirium tremens.

V. What are the individual (physical, mental) and social effects of inebriety, acute and chronic?

It has not been shown that the moderate use of alcoholic beverages by the average normal adult produces harmful physical or mental effects. On the other hand, immoderate use can lead to serious physical and mental disorders of the individual and tragic effects on society.

The acute effects of an intoxicating quantity of alcohol on mental and physical actions and efficiency are all too well known. If such a quantity is large enough to cause death the only well defined evidence of an alcohol action on the body tissues is a swelling of the brain and liver cells and some change in the lining membrane of the stomach.

Chronic or habitual use of alcoholic beverages to the point of inebriety may lead not only to the mental disturbances mentioned in the previous paragraph but also, directly or indirectly, to diminished efficiency and physical degeneration in organs other than the brain.

Because habitual immoderate use of alcoholic beverages is often associated with the failure to eat enough essential foods, vitamin deficiencies and other nutritional disorders are of frequent occurrence in the alcoholic addict. One of the most common of these is beriberi. This may involve the nervous system (one type is referred to as "alcoholic neuritis"), or the heart. It is due to a deficiency in the intake of Vitamin B_1 (thiamin) and not to alcohol per se.

Irritation of the lining of the stomach (gastritis) with resulting impairment of appetite and digestion is of frequent occurrence in the case of the chronic alcoholic patient.

Cirrhosis of the liver ("hobnail" liver) is found more often in those who use alcohol immoderately than in moderate drinkers or abstainers. The exact cause of this liver disease either in those who use alcohol or in abstainers is not known.

Excess indulgence in alcohol tends to lower body resistance to infectious diseases. This has been especially noted in pneumonia and tuberculosis.

Studies on the effect of alcohol on the length of life show equal life span expectancies for abstainers and moderate drinkers. The chronic heavy drinker, however, has a definitely shorter life span.

There is no good evidence that even long continued excess consumption of alcohol leads to hardening of the arteries (arteriosclerosis), kidney disease, cancer, or changes in the germ plasm.

If alcohol were a habit forming drug in the same sense or to the same degree as are morphine and cocaine, all or nearly all moderate drinkers would sooner or later become chronic alcoholic addicts. This is not the case. In fact only a small percentage of the people using alcoholic beverages in moderation throughout their adult lifetime become alcoholic addicts. What are the *special factors* or *causes* leading to alcohol addiction in these few? We do not know. There are many guesses, many theories. When we do know what these factors or causes are, perhaps alcoholic addiction can be entirely prevented. That should be the goal of all intelligent people. It should be noted that through the medium of heavy drinking a true alcoholic habit may be developed.

Of major importance is the fact that hand in hand with chronic alcoholism go such social and economic catastrophies as unemployment, crime, family disruption and neglect, etc., with all the appalling ills (individual and social) inherent in these tragedies.

THE CORRELATION OF BIOLOGY AND LITERATURE*

ALFRED F. NIXON

Dunbar High School, Washington, D. C.

AT the present time when there is so much talk about curriculum revision, integrated teaching, and the development of social-minded individuals, we must be ever on the alert to correlate our subjects with others rather than build them up as isolated entities. The sciences seem to be guilty of this sort of isolationism.

When biologists become afflicted with that type of professional vanity which takes them into absolutism concerning conclusions and answers to the "why" questions, especially where the children of grade school and high school levels are concerned, it seems that they are in conflict with the very essence of the aims of science teaching. Much of the biologist's working material is, by necessity, dead and non-living, but a great deal can be done to vitalize it by having the child experience through poetry and prose many of those things which he cannot experience in actuality. Even in cases where the child can have actual experience with certain natural phenomena, it is worthwhile to compare their impressions and reactions with those recorded in literature.

It is just as important that teachers of literature make attempts to correlate their work with biology and the other sciences. The gap that exists between sciences and English as taught in most of our modern schools is possibly greater than that between any other two subjects. The attempt to close this gap is being made by some of the teachers of English. They sometimes have teachers of biology visit their classrooms to discuss the biological phases of certain English works like Huxley's essay, *On a Piece of Chalk,* and works dealing with trees, birds, flowers and other nature subjects. It would be effective also to have students of the English class who have studied biology or who are studying it present the biological aspects after conference with the biology teacher.

Students enjoy reading such works as Maeterlinck's *The Life of the Bee* and *The Intelligence of Flowers.* In these works there is frequent use of metaphors such as "male flowers, which see," "full of hope," "awaits," "hesitate," "deliberately break the bond that attaches them to life." There are those individuals who might object to the use of these metaphors on the ground that they are unscientific. Nevertheless, it must be admitted that the students like them, and if they have had biological training they know the truth. They are then able to determine the metaphorical aspects, whereas without training in biology they would confuse the scientific with the poetic.

The teacher of biology must not fail to impress upon his students that factual information and exactness are essentials in any science, but he must not do this by the elimination of emotion and contemplation which are so much a part of man. For as Beston, in his Foreword to West's *The Nature Writers,* says,

> Torn from the earth and nature, and put to dwell in a world of consciousness abstract as a kind of mathematical formula, man becomes inhuman, changing to something less than man or something more, and both are monsters, the last the more dread.

And elsewhere he says,

> The function of the writer on Nature is therefore akin to that of the poet. It is his task to give depth and colour to the adventure of human life, to touch the imagination of his readers, exalt their sense of beauty and mystery,

* An abstract of a report submitted in partial fulfillment of the requirements for the Doctor of Education degree at New York University. The thesis is entitled *Teaching Biology for Appreciation: The Correlation of Biology with Art, Literature, and the Social Studies.*

and fortify in their souls that power of intelligent awareness with which they look out upon their world.[1]

The Nature Writers originated, says the author, in a new course of his at Dartmouth. Its purpose was to bring before as many students as possible great books on the out-of-doors. Nature writing, he further contends, has produced some of the finest literature in our language, and those listed in this work are among the best nature books ever written.

This little volume will be of inestimable value to both the teacher of science and the teacher of English. It contains works about natural science that meet the approval of experts in the field of literature. It is annotated so that the teacher can give the student some idea of the contents of any book which he may care to read. Practically all types of plants and animals are covered. Thus it might be possible for the teacher of biology to suggest collateral reading in connection with any unit in the course.

This idea of correlation can be effected without sacrificing any of the present important objectives of the science or the English programs since the main aim must always be the development of the "whole" individual to live in a scientific and social environment.

It is surprising what interesting literature of a biological nature has been written by the early American fathers. When studying reptiles the student might be asked to read William Byrd's "The Alligator" from *The History of the Dividing Line.* No more interesting essays could be desired than those on *The Flying Spider* and *Nature* by Jonathan Edwards. Benjamin Franklin's *The Ephemera* and his *Dialogue Between Franklin and the Gout,* taken from his autobiography will be greatly enjoyed by most high school students. The well-known Revolutionary figure, Philip Freneau, gave American literature the first memorable poem of nature in *The Wild Honey-Suckle.* These and many other appropriate bits of literature may be found in *American Poetry and Prose* by Norman Foerster.[2]

In attempting to interest the students in correlating their biology and English the writer suggests that they be encouraged to describe certain plants, animals, and structures studied, or relate processes learned in biology, when their English teachers assign them essays on description and narration. In a large measure they like this type of thing. They enjoy describing something, without calling its name, to see if the English teacher can determine what it is. Biology also affords interesting materials for essays on comparison.

Great names, including many scientists, have in so many words attempted to show the compatibility of science and poetry. Virginia Shortridge, in her beautiful anthology *Songs of Science,* attests this fact. The aim of her anthology is "to link the advance of Science with the rhythmic evolution of Beauty, the revelation of Knowledge, which is permitting men to lift the veil between the concrete and the ideal, as it is expressed in terms of poetry." She states,

> No true scientist can escape being a poet, for all wisdom flows in waves. The best receiver is he to whom the vibrations bring a harmony which can be caught, translated, and used in spreading the Beauty of Truth, which men have faithfully sought since the beginning of things.[3]

Some thoughtful men have acquiesced to this philosophy. Dr. Edward Livingston Trudeau "Was a firm believer in the poetry that is in all scientific effort—or should be . . ." Charles Darwin, too, "Was one of those elect persons in whose subconscious, if not in their conscious nature, is implanted the realization that 'science is poetry,' and in a field altogether

[1] Henry Beston, Foreword to *The Nature Writers,* by Herbert F. West.

[2] Norman Foerster, American Prose and Poetry. Houghton Mifflin Company, 1934.

[3] Virginia Shortridge, *Songs of Science,* p. ix.

remote from the poetry and art of convention he was alike poet and artist." [4] Havelock Ellis further corroborates this idea.

> Imagination is a constructive part of all thinking. We may make distinctions between practical and scientific thinking and disinterested aesthetic thinking; yet all thinking is finally a comparison. Scientific fictions are parallel with aesthetic fictions. The poet is the type of all thinkers; there is no sharp boundary between the region of poetry and the region of science. Both alike are not ends in themselves but means to higher ends.[5]

In using a poem or story for the purpose of developing appreciation, it is important to create the proper attitude and mood of the class. For example: If poems on birds are to be used there should first be set up an exhibit on birds including some pupil projects. Colored lantern slides of birds and some victrola records of bird songs might also be presented. The poem should be read first for general appreciation. It should be read well with expression and with the proper rhythm. Analysis and general discussion might follow.

A few of the ways by which poetry can be correlated with biology are related below.

One of the important laws of science touched upon in biology is The Law of the Conservation of Energy and Matter. Each teacher has his method of getting this law over to the child. Whatever the method, I feel that the reading and discussion of William Cullen Bryant's *Thanatopsis* will increase the child's appreciation of the law. The assignment could be made for the entire class to read the poem, or an individual who reads well, to read it to the class. In some cases the teacher himself might read the poem aloud. Whichever of these methods is used, the class is asked to be on the alert for those lines that best convey the idea of the law under discussion. How well do the following lines taken from the poem convey the idea!

> Yet a few days, and thee
> The all-beholding sun shall see no more
> In all his course; nor yet in the cold ground,
> Where the pale form was laid with many tears,
> Nor in the embrace of ocean, shall exist
> Thy image Earth, that nourished thee, shall claim
> Thy growth, to be resolved to earth again,
> And, lost each human trace, surrendering up
> Thine individual being, shalt thou go
> To mix forever with the elements,
> To be a brother to the insensible rock
> And to the sluggish clod, which the rude swain
> Turns with his share and treads upon; the oak
> Shall send his roots abroad and pierce thy mould.
> Yet not to thine eternal resting-place
> Shalt thou retire alone, nor couldst thou wish
> Couch more magnificent. Thou shalt lie down
> With patriarchs of the infant world, with kings,
> The powerful of the earth, the wise, the good,
> Fair forms, and hoary seers of ages past,
> All in one mighty sepulchre. The hills
> Rock-ribbed and ancient as the sun, the vales
> Stretching in pensive quietness between;
> The venerable woods, river that move
> In majesty, and the complaining brooks
> That make the meadows green; and poured round all,
> Old Ocean's gray and melancholy waste,—
> Are but the solemn decorations all
> Of the great tomb of man. The golden sun,
> The planets, all the infinite host of heaven,
> Are shining on the sad abodes of death,
> Through the still lapse of ages. All that tread
> The globe are but a handful to the tribes
> That slumber in its bosom.

Appreciation of the wonders of nature and the desirability of conservation might be more indelibly impressed by the reading of Bryant's *A Forest Hymn* and other similar poems. Ralph Waldo Emerson's *Forbearance*, quoted below, conveys the idea.

> Hast thou named all the birds without a gun?
> Loved the wood-rose, and left it on its stalk?
> At rich men's tables eaten bread and pulse?
> Unarmed, faced danger with a heart of trust?
> And loved so well a high behavior,
> In man or maid, that thou from speech refrained,
> Nobility more nobly to repay?
> O, be my friend, and teach me to be thine!

When such terms as "evergreen," "excurrent," and "nondeciduous" are used in discussing trees, reference might be made to the first few lines of Longfellow's *Evangeline* to aid the student in remembering examples of such types.

[4] Shortridge, *op. cit.*, p. xiii.
[5] *Loc cit.*

This is the forest primeval. The murmuring
pines and the hemlocks
Bearded with moss, and in garments green,
indistinct in the twilight
Stand like Druids of old, with voices sad and
prophetic,
Stand like harpers hoar, with beards that rest
on their bosoms.

There is, too, the reference in biology to the spreading or "deliquescent" type of tree which is just the opposite of the previously mentioned "excurrent" or "running out" type. Longfellow's *The Village Blacksmith* will help in fixing in mind "the spreading chestnut tree" as an example of the deliquescent type.

When studying birds and bird life no more attractive appeal, from the appreciation point of view, is imaginable than *Robert of Lincoln* by William Cullen Bryant. The sounds at the middle and end of each stanza are attactive to children. In the first three stanzas, quoted further along, the following ideas concerning birds are conveyed together with a few others.

1. Birds usually build their nests in inconspicuous places.
2. Male birds are more gaily dressed than are females.
3. Male birds are the better singers.
4. Birds take on new feathers usually around the mating time.
5. Some birds are named by the sounds they make.
6. Female birds stay at home more than do the males.

The last generalization affords an excellent discussion from the social studies point of view.

All through the poem one is able to grasp ideas of bird life in general and of the bob-o'-link in particular.

Merrily swinging on brier and weed,
Near to the nest of his little dame,
Over the mountain-side or mead,
Robert of Lincoln is telling his name:
Bob-o'-link, bob-o'-link,
Spink, spank, spink;
Snug and safe in that nest of ours
Hidden among the summer flowers.
Chee, chee, chee.

Robert of Lincoln is gayly drest,
Wearing a bright black wedding-coat;
White are his shoulders and white his crest.
Hear him call in his merry note:
Bob-o'-link, bob-o'-link,
Spink, spank, spink;
Look, what a nice new coat is mine,
Sure there was never a bird so fine.
Chee, chee, chee.

Robert of Lincoln's Quaker wife,
Pretty and quiet with plain brown wings,
Passing at home a patient life,
Broods in the grass while her husband sings:
Bob-o'-link, bob-o'-link,
Spink, spank, spink;
Brook kind creature; you need not fear
Thieves and robbers while I am here.
Chee, chee, chee.

Often there arises in the classroom the opportunity to speak of the dangers of narcotics to growing youth. Many young people are guilty of this crime because in their desire to follow grown up practices, they are heedless of the harm that may result from such practices. In this connection reference might be made to an early English reprint by James I, King of Great Britain, entitled, *A Counterblaste to Tobacco*. By looking up this very old work the child will be impressed not only with early ideas concerning the harm and undesirability of tobacco, but also the style of writing and printing of early English. The quotation of a portion of a poem by Joshua Sylvester, found in the reprint,[6] will give some insight into the ways in which tobacco was considered injurious and offensive.

. . . How inster will the Heau'nly God,
The, Eternal, punish with infernal Rod,
In Hell's darke (Fornace, with black Fumes,
to choak)
Those, that on Earth will still offend in smoak?
Offend their Friends, with a Most un-Respect:
Offend their Wives and Children, with Neglect:
Offend the Eyes, with foule and loathsom
Spawlings:
Offend the Nose, with fllthy Fumes exhaling;
Offend the Eares, with loud lewd Execrations:
Offend the Mouth, with ougly Execreations:
Offend the Sense, with stypefying Sense:
Offend the Weake, to follow their Offense:
Offend the Body and offend the Minde:

[6] James I, King of Great Britain, *Counterblaste to Tobacco*, p. 118.

Offend the Conscience in a fearefull kinde:
Offend their Baptisme, and their second Birth:
Offend the Maiestie of Heau'n and Earth.
Woe to the World because of Such Offenses;
So voluntaire, so voyd of all pretenses
Of all Excuse (saue Fashion, Custome, Will)
In so apparant, proued, granted, Ill.
Woe, woe to them by Whom Offences come,
So scandalous to ALL our CHRISTENDOME.

Very often poems of the type which follows will make impressions that all the talking and experimentation can not convey.

Carpe Diem

Youth, that pursuest with such eager pace
Thy even way,
Thou pantest on to win a mournful race;
Then stay! oh, stay!
Pause and luxuriate in thy sunny plain;
Loiter,—enjoy;
Once past, thou never will come back again,
A second boy.
The Hills of Manhood wear a noble face,
When seen from far;
The mist of light from which they take their grace
Hides what they are.
The dark and weary path those cliffs between
Thou canst now know,
And how it leads to regions never-green,
Dead fields of snow.
Pause, whilst thou mayst, nor deem that fate
thy gain,
Which, all too fast,
Will drive thee forth from this delicious plain,
A man at last.

R. Monckton Milnes,
Lord Houghton

When studying that phase of biology that deals with human physiology there are a number of poems applicable. The writer refers especially to such types as "Machines—Or Man?" by Elizabeth Newport Hepburn in which she says,

If one were sound-proof, like some well-built house,
And proof against the weather, Winter winds
And dull, reluctant, stagnant Summer heat. . . .

If one were built for service, like a car
With shock-absorbers for rough travelling!
And if our souls were radio-equipped,
So that we thought the thoughts. . . .

Mere man is ill-constructed for this Age!
We need inventors who could speed us up
And see that we're equipped with everything
To safeguard us. . . .

No suffering in this well-ordered world,
For we would all inoculate our young
So that they need never know Love's bitter-sweet,
Ambition's cruel spur or passion's prayer,
The acid bite of failure. . . .

And yet . . . I wonder! Can machinery
Share in the spring, live through an April day?
Or dream, imprisoned, of Love's mystery,
And hope, in Winter, for the kiss of May?

These lines might be used most effectively in developing appreciation of the body structure and functions with special reference to the nervous system.

When studying about the vast changes that the earth and its inhabitants have undergone throughtout the ages, and through which they are still going, poems like *The Origin of Life* by Alfred Noyes can be used.

Reference to literature often stimulate students themselves to try their hand at poetry. It requires much thought to put certain biological information, laws, and principles, into verse. The more facts learned the greater the opportunity to rhyme. Attempts at poetry fix the ideas more indelibly in mind. The writer was pleasantly surprised one day when, after completing the unit, The Earth and Its Inhabitants Have Been Undergoing Vast Changes Throughout the Ages, a student handed him a poem which he had composed. It contained practically every important idea associated with the concept of change. Undoubtedly, this student will ever remember these important associations connected with this particular unit. Students in later classes have expressed great interest when this poem was read to them at the completion of the unit. The poem follows:

Evolution's Gifts

From a cosmic source they came
Those great white hot balls of flame.
There are many of them I say,
Cooling, cooling, all the way
Down to this present day.

We call them planets in the sky;
A small one is where my interests lie.
It is our earth whose outer crust
Formed partly of an ancient rust
By bacteria with an iron lust.

Then the algae, blue and green,
Seaweeds and Psilophyton came
Tree-ferns, club mosses too displayed
In the Mesozoic shade
Their ancient forms by nature made.

Now, what next do we see?
'Tis the sequoia, the redwood tree.
Withstanding ravages of time
Live yet to see true flowers fine,
Evolved by Nature down the line.

As flora evolved, did fauna too.
From one-celled forms to me and you.
The highest fauna we do deem
Homo sapiens or human being,
Which came from lower forms—it seems.

Pithecanthropus erectus, or Java man,
French Cromagnon, African Rhodesian;
From England hailed a Piltdown caste,
Heidelberg from Germany; not least but last,
Peking from China—all fossils of the past.

The changing environments have changed
The appearance of all of those pre-named.
From earliest times to latest date
Those changes have resulted in racial hate.
To amend this I pray is not too late.

Yes, flora changed and so did we
But flora seem content to be
With what nature them provided.
While we would have each other chided,
Hated, and humanity divided.

I hope that blessed day will come
When human beings digress from
The present state of resentment,
Will contemplate and then repent.
Let that day soon be Heaven-sent!

—Llewellyn Constantine

Commenting on the need for stimulating students to creative expression, Otis W. Caldwell said,

> In literature as well as in some other subjects, we have regarded pupils as learners, not prophetic doers, and have sought to instruct them, and have not tried to lead them to create. . . .We need to recognize that many, possibly most, pupils are essentially creative, but that our systems of education have forced adult standards and judgments until timidity regarding one's own writing has too often supplanted the naturally adventurous spirit of those who really wish, and very often slyly endeavor, to express themselves in verse and prose. They cannot truly enter into the world's literature except by their own endeavors to write; then in this trying some reveal to themselves and to us the unmistakable evidences of the new writers of our own day.
>
> For five years we have watched with fascination as a group of high school pupils slowly have come to understand that poetry by pupils is really respectable. The shyly submitted rhyme which in by gone days, even still in many places, is falsely regarded as evidence of weak emotion is slowly assuming the dignity of real production.[7]

It is not necessary that the biology teacher go into the mechanics of poetry. He will not have the child classify lines as dactylic hexameter, iambic pentameter, iambic tetrameter and the like. That is to be left to the teacher of literature.

In this article the writer has suggested only a few of the many possibilities for the correlation of literature and biology. One can be on the alert for others, in newspapers, magazines, and so forth, that might be applied to classroom work.

An ideal bibliography that might be used in the correlation of science and literature has been compiled by Woodring, Oakes, and Brown[8] under the heading English and Science, pages 365–379.

If appreciation is to be an aim in the teaching of any subject, be it art, literature, or science, it must be kept constantly in mind by the teacher. According to available evidence appreciation is specific and is not assured as a by-product of creation or production. "If learning is specific, generalization and transfer must be provided for in the teaching process for they are not produced in the mere nature of the child's learning."[9]

[7] Otis W. Caldwell, in Foreword to *Creative Youth*, by Hughes Mearns, pp. vii–ix.

[8] Maxie N. Woodring, Mervin E. Oakes, and H. Emmett Brown, *Enriched Teaching of Science in the High School*. Teachers College, Columbia University, 1941.

[9] Robert K. Speer, *Measurement of Appreciation in Poetry, Prose and Art, and Studies in Appreciation*, pp. 76–77.

A STUDY IN THE CORRELATION OF EDUCATIONAL ACTIVITIES THROUGH A FUNCTIONAL DEMONSTRATION MUSEUM *

MICHAEL SERENE

Ambridge High School, Ambridge, Pennsylvania

MANY institutions of higher learning begin their school year with varied problems. Many schools often find themselves facing the common difficulty of crowded classes. This may be caused either by a natural increase in enrollment or by a decrease in faculty members. Other schools with large numbers of classes in certain subjects may suffer severely from the lack of adequate equipment. Especially in laboratory work and in the presentation of illustrative material is this need felt. Of necessity, in such situations, laboratory work has to be curtailed drastically or eliminated entirely. What little illustrative material is available must be used sparingly because of the difficulty in frequent setting up and moving of equipment from one location to another.

The Biology Department at Kent State University had for a number of years been facing this problem of crowded classes and limited equipment in General Biology. The course in General Biology had been taught by four instructors, each with a different field of specialization. Those students who had been taught by the botanist emerged from the course with a good knowledge of botany. On the other hand those who had been taught by the zoologist completed the course with a fine understanding of zoology. Consequently some diversity of instructional method and administration resulted each year.

At the beginning of the school year 1936–37, it was felt that for the 310 students in General Biology some plan should be devised to overcome these disadvantages. It was thought desirable to strive for the attainment of the following objectives: to make available to students who wished it an opportunity to do individual laboratory work, to afford a greater use of illustrative material, to encourage the development of freedom and initiative in superior students while assuring aid for the poorer students, to provide for some uniformity in subject matter and teaching method, and to achieve the informality of the small class.

To this end the *New Plan* was adopted at Kent State University for the term in 1936–37. The *Plan,* in brief, for a normal week's program consisted of two general lectures for all students, one conference period, the use of textual material, library references, and voluntary visits to the Demonstration Museum.

Every Tuesday and Thursday morning, from eight to eight-fifty o'clock, students assembled in the University Auditorium to hear lectures by one of the instructors on the staff. The lecturer spoke from the stage and illustrated his lecture by means of a portable blackboard. On occasions charts and other visual material were used.

As students entered the auditorium, they were handed a mimeographed sheet containing the following information: (1) advanced assignments in the text, (2) notices of importance, such as future examinations, classes, attendance reports, and grade reports, (3) the week's program in the Demonstration Museum. Staff members of the Biology Department planned the course procedure and gave lectures in their specific fields of specialization.

Enough conference sections were scheduled that each section did not include more than twenty-five students. Throughout the semester each section met once a week at a designated hour for a full class period with

* This paper is based on the author's Master's Thesis *The Demonstration Museum as a Part of the Course in General Biology.* Kent State University, Kent, Ohio, 1937.

the same instructor. In this class period, problems arising in connection with the course were discussed. Each instructor conducted his conference section as he saw fit. In most cases questions on the general lecture or text material took up the entire period. Short reports, quizzes, and supplementary discussions were included in the class conference meeting.

The text material used in the course was a mimeographed edition of "An Introductory Course in Individual and Social Biology for College Students" by Dr. Harry A. Cunningham, head of the Biology Department.

The basis for the student's final grade in the course was determined by his average in four intensive examinations given at the end of each unit throughout the semester. These examinations were composed by the Museum assistant and members of the staff who had given lectures on that unit.

The *New Plan* had as its focal point a functional Demonstration Museum. This Museum was set up in order to make the most efficient use of the limited equipment on hand in the department, and in order to provide for any expansion within the regular course. The Museum was located in a large classroom, size fifty-six feet six inches by thirty-nine feet ten inches, of which approximately eleven hundred square feet of space was available for use.

In the Museum students were presented with demonstrations, charts, models, films, and actual specimens of the subjects which had been discussed in the lectures and studied in the text.

The writer was given an assistantship at the beginning of the school term and placed in complete charge of the Museum. There was no other cost of any importance in connection with the Museum beyond payment of the assistant's salary. Most of the material for exhibits was in the Biology Supply Room and various other rooms in the department. Consequently, only time and effort was spent in collecting and arranging material for the exhibits. A few glass plates, table lamps, and live cultures of protozoa constituted a minor source of expense. Most of the live material was raised by the assistant.

The furniture in the Museum included a large stone-topped demonstration table at the front of the room, with water, electric, and gas connections, a small table to the west side of the demonstration table, five rows of acid-proof black topped classroom tables, and two large tables in the rear of the Museum. The first five rows of acid-proof tables were of the same type, while the last two tables were wider and longer with a plain varnish finish. Exhibits were usually arranged on the third, fourth, and fifth row, and occasionally upon the second row of tables. These acid-proof black topped tables lent themselves well to this type of work, as exhibits could be viewed on the Cafeteria plan, the students passing between the rows of tables.

The Museum was kept open four afternoons a week, Tuesday through Friday from 1:00 to 4:00 P.M. Monday afternoon was used by the assistant in making and setting up exhibits for the coming week. Often the Museum was kept open until 4:30 or 5:00 P.M. to accommodate students who wished to spend more time there or who had no other opportunity to visit it.

Each classroom table was equipped with a small table lamp, which was found useful in illuminating the exhibits or furnishing light for microscopic study. The exhibits were so arranged that students viewed them from the rear of the tables. In this manner students could sit down and spend as much time as they desired in studying the exhibits. In a few cases exhibits were set up on the front demonstration table.

The south side of the room proved valuable for hanging charts. Charts completely covered the walls during some weeks. A bulletin board, eleven feet long and four feet wide, was used for lecture notices, charts, and announcements relative to Museum work. This bulletin board was located on the west side of the room.

A film projector was used in showing films. It was placed on the last row of black topped tables and the film was projected on the screen at the front of the room.

The desirability and value of Museum attendance were indicated on a mimeographed sheet handed to the students at the beginning of every lecture. Although at no time was there any attempt made to require attendance, it was made known that a few questions on examinations would be derived from Museum exhibits. The staff felt justified in taking this step, since it considered the Museum a part of the course.

From the beginning the Museum proved popular with students. The few who attended and observed the exhibits during the first week spread the news to other members of the course. An advantage in having the Museum open on four afternoons was that students could come during their free time. It was felt that all students would have some free time at least once during the four afternoons the Museum was kept open. It was believed also that attendance would be distributed by this plan and that the possibility of "crowding" on certain days might be lessened.

A correlation between the exhibits in the Museum, text material, and lectures, was maintained as far as possible, with the exception of films, whose delivery dates were often late. No material was presented which had no bearing on the subject or topic being presented. In many instances lectures for the week were so closely related that no change was necessary in the exhibits for the entire week. In other instances materials were changed on Wednesday night to provide on Thursday afternoon a complete new set of exhibits which correlated with the lecture given that morning.

Exhibits used in the Museum may be classified under four heads: (1) Charts, (2) Models and mounted specimens, (3) Demonstrations, and (4) Films. Two types of charts were used in the Museum, commercial charts purchased from biological supply houses and charts made in the department by students. Commercial charts were large wall-type charts, hung from easels, and small table charts. Student charts were made on white oilcloth.

Models of organisms, such as ameba, paramecium, rabbit, mounted mice, etc., constituted the second group. Where explanations to accompany these exhibits were required, a typewritten sheet, with the necessary explanation or definition, was placed under glass at the right side of the model. In instances where parts of the models or mounted specimens were labeled, parts were placed on large squares of black cloth. The cloth made a good background for small white squares of paper on which were printed the names of the parts of the model. These white squares of paper were connected to the models by white strings pasted to the structures named on the paper. Occasionally models and specimens were accompanied by problem sheets. These sheets stimulated considerable interest among the students.

Demonstrations included preserved specimens, slides of various types, imitations of scientist's experiments, and live material. Where microscopes were used, a square of thick white paper, usually with a drawing of the object to be viewed and a short explanation of the material on the slide, was placed at the right of the microscope. This procedure was varied by using a white square of cheese cloth or black cloth for a background. The black or white cloth was very effective in exhibits where the material had to be viewed with the naked eye, such as exhibits of preserved chick embryos, mice embryos, seeds, growing seedlings, etc.

Students showed the greatest interest in the demonstrations in which they could take an active part. In the demonstration of protozoa, students took delight in pipetting their own material from cultures and in viewing this material under the micro-

scope. Many students became so interested that they were encouraged to make drawings of their observations.

Some students became so stimulated through their participation in the demonstrations that they expressed the desire to do some sort of laboratory work. Other students wanted an opportunity to work on problems of their own. Although students were not required to do laboratory work, those who showed a desire to do so were given every possible encouragement and help. Materials for individual laboratory work were always made available.

A factor which helped develop interest in individual laboratory work was the ease of checking out supplies from the supply room. Students were permitted to check out any supplies they needed in connection with their problem or project simply on their signature. A few examples of the type of individual work done included drawings of the common protozoans, food tests, slide making, and bacterial analyses of a few products.

Films played an important part in the function of the Museum. The films were obtained from the Visual Instruction Exchange, Columbus, Ohio. Since the Exchange is a state institution, the only cost incurred was the transportation charge. Films were always shown at 1:00 and 3:00 P.M. on the days on which they were scheduled. Notices to this effect were put on the mimeographed sheets handed out to the students at the beginning of each lecture.

Another phase of the work in the Museum was the exhibition of previous examinations a week before regularly scheduled examination. A large proportion of students came in to look over these old examination questions which furnished good review material. The assistant was kept busy answering questions or settling debates which arose among students concerning questions on the sample tests.

The assistant served frequently in a tutorial capacity. Often students brought their lecture outlines and texts to the Museum and asked to have further explanation given of some phenomena discussed in the text or lecture. Many came to be tutored on some phase of the work with which they were having difficulty.

The success of any type of exhibit or Demonstration Museum where attendance is voluntary is determined in part by the number and lengths of visits to that Museum. The results of any testing program having reference to that Museum and the reactions of those in attendance are also factors bearing on its success. Data obtained showed that the amount of time spent in the Museum per student ranged from fifteen minutes to forty hours per semester. Of the three hundred ten students taking the course, half that number spent from fifteen minutes to five and a quarter hours in the Museum during the semester.

One method of determining, in part, the success of the Museum was to correlate the average scores on the four examinations given with the total amount of time students had spent in the Museum. The final average scores of all students in the course were ranked in order from the highest to the lowest score. This list was divided into quartiles. These quartile groups were then correlated with the total amount of time each quartile had spent in the Museum. Test scores were found to have a positive correlation with the total amount of time spent in the Museum. That is, those students who had spent the most time in the Museum ranked in the upper quartile, while those who had spent the least time in the Museum ranked in the lowest quartile.

Some data were worked out concerning those students who went beyond the regular requirements of the course and asked permission to do individual laboratory work. Thirty-eight students asked permission to do simple dissections, make slides, models, drawings, simple bacterial analyses, and other laboratory work associated with a biology course. Since no laboratory work

was required, it was interesting to discover how the thirty-eight students ranked on the examinations. Fifteen ranked in the upper quartile, seven in the second, thirteen in the third, and three in the lowest quartile. Twenty-two students who had been activated in laboratory work ranked above the median for their class.

To determine their reaction or attitude to the Museum, the writer asked two conference sections to give an anonymous criticism of the Demonstration Museum. Forty-two criticisms were written. Only one criticism out of the forty-two had anything in it that might have been considered unfavorable. That student thought that there should have been more information concerning tests on display in the Museum. Some students thought the Museum attendance should be made compulsory. A majority advocated required work of some sort. Three students asked that the Museum be opened during the mornings.

CONCLUSION

No definite generalization can be drawn from this study as yet. The Demonstration Museum went from a temporary location, half time basis, to a permanent location, full time basis, in 1939–40 when a new science building was occupied.

In 1941 the *New Plan* was abandoned, temporarily, because of the loss of students and instructors due to the war.

The results of this experiment merit further study.

Based on incomplete data, evidence seemed to indicate that the *New Plan* achieved some uniformity of teaching method, utilized space and equipment to its maximum advantage, afforded time for socialized recitation peculiar to small classes, afforded students an opportunity to do individual laboratory work impossible in a lecture course, and made it possible for all students to receive the benefit of the special knowledge of each faculty member.

THE ABILITY TO TEST HYPOTHESES *

MORRIS L. ALPERN
Tottenville High School, New York City

A COMMONLY accepted value to be derived from the study of science is the ability, in a problem situation, to think and act in accordance with the rules of scientific method. However, there appear to be as yet no well-established methods to accomplish this aim of science teaching. Neither can the science teacher proceed with any assurance in devising methods for the development of scientific thinking until the abilities involved have been adequately defined and reliable means for appraising them are available.

It seems unfortunate, but probably true, that teachers tend to emphasize in their teaching that which can be measured, namely, the facts and skills which can be isolated. It would therefore seem logical that if the abilities involved in scientific thinking could be isolated and measured it would serve as a stimulus in redirecting science teaching toward the achievement of this goal.

The complexity of the process of scientific thinking is sufficient to warrant an atomistic approach to elucidate the abilities involved. According to this view certain separate, well-defined, though related, abilities may be recognized which are associated with the well-known steps in scientific thinking; namely, defining the problem, proposing hypotheses, testing hypotheses, drawing conclusions, and so on.

* Based on a Doctor of Philosophy thesis entitled, "The Ability to Test Scientific Hypotheses: An Analytical Study of the Ability of a Selected Group of High-school Students to Suggest and Select Procedures for Obtaining Scientific Evidence to Establish the Validity of Scientific Hypotheses," completed in the School of Education, New York University, 1944 (Unpublished).

Through the study of these isolated abilities and their relationship to one another it should be possible to gain a better understanding, and consequently a more reliable measure of the more general ability to think scientifically.

Low correlations between each of these postulated abilities and such general factors as intelligence, mental maturity and reading grade would be taken as indications of their *uniqueness*. Low intercorrelations among these *abilities* would further reenforce the idea of their *separateness*. Tiechman [1] has indeed found that there are low positive correlations between the *general factors* and the "ability to make conclusions."

THE PROBLEM

The purpose of this investigation was (1) to determine the degree of ability of a selected group of high-school students to test scientific hypotheses, and (2) to evaluate certain measurable factors related to this ability; namely, intelligence, reading ability, chronological age, sex and previous terms of high-school science.

SCOPE AND MATERIALS

The subjects of this investigation were approximately six hundred students enrolled in the science classes at Seward Park High School in New York City. The sources of data included (1) the students' permanent record cards, from which were secured measures of intelligence and reading ability, based upon standardized tests, chronological age, sex, and previous terms of high-school science, and (2) measures of the abilities (a) to *suggest* procedures, and (b) to *select* procedures to test scientific hypotheses. These measures were based upon scores obtained on original tests which were specifically constructed to measure these abilities.

Test I, the ability to *suggest* procedures, consisted of twenty-seven items, each composed of a problematic situation and a hypothesis offered as an explanation of the problem. The student was asked to describe the procedure (experiment) which he thought best to determine whether the hypothesis was true or not. This test was validated by four experienced teachers of science on the basis of five criteria set up for the purpose. Test I was administered to approximately 250 students representing a sample of the student body investigated. The test was given in two sessions, the total working time being eighty minutes.

The items of the original test, *Test I*, were reframed to form a second test, *Test II*, designed to measure the ability to *select* procedures to test scientific hypotheses. Each item consisted of (1) a situation, (2) a statement of the problem involved in the situation, (3) an hypothesis offered as an explanation, and (4) four suggested procedures. Experiments proposed as answers by the students who took the original test, Test I, were used as alternatives for the multiple-response test. The student was asked to check the procedure which he thought best to find out whether the hypothesis was true.

The preliminary form of Test II was revised on the basis of (1) an item analysis which consisted of (a) a determination of the *discriminating power* * of the individual items, (b) the *range of difficulty* ** of the items, and (2) criticisms submitted by a group of leading science educators from all parts of the country. The final form of Test II consisted of twenty items which could be administered in a single forty-minute period.

The reliability of Test II, based upon 259 cases, was .75; the *index of reliability* *** .87.

The validity of Test II was determined

* The reliability of the items in discriminating between the highest 25 per cent and the lowest 25 per cent of the students.

** The difficulty of an item was determined by the per cent of students correctly solving the item and this percentage was then expressed in sigma terms.

*** Correlation between obtained scores on a given test and true scores in the function measured by the test.

by four "indirect" methods: (1) the judgments of forty-one leading educators in science, (2) the *index of reliability* (.87), (3) the *discriminating power* of the individual items of the test which was found to be satisfactory according to the standards reported in the literature, and (4) the *range of difficulty* of the items (90 to 21 per cent) and the *average difference in difficulty* between successive items (.12 in sigma tems).

PROCEDURE

Test I was administered to 248 students. The papers were not scored, but a tabulation and critical analysis of the responses were made. Test II was administered to 441 students. The papers were scored by the investigator, using a key that had been agreed upon by the jury of "experts."

FINDINGS

The findings of this investigation are based upon a statistical analysis and interpretation of the data. The "free response" answers to *Test I* when analyzed revealed the following:

1. A wide range in the number of items completed by the students tested.

2. A great number of different procedures were offered for testing some of the hypotheses (for one item as many as twenty-seven different procedures were tabulated).

3. In many instances the "procedure" suggested was not an experiment at all, but merely the word "true" or "false" followed by a reason for the assertion. The *true-false-reason* type of response would seem to indicate that the student was more inclined to "jump to a conclusion" by relying on his own previous information regardless of its accuracy, than to attempt an experimental procedure to verify the hypothesis. It would appear, therefore, that in such cases the individual does not possess the "habit of delayed response."

The results obtained by administering *Test II* are presented in Table I. The

TABLE I

RESULTS ON TEST II. ABILITY TO SELECT PROCEDURES

Group	N	Mean	S.D.
Grade IX	100	8.32±.22	3.20
Grade X	211	10.26±.18	3.92
Grade XI	89	11.96±.31	4.32
Grade XII	41	11.43±.41	3.84
Entire Group	441	10.26±.13	4.08

mean score for the entire group was 10.26 (maximum score, 20). With the exception of Grade XII there was an increase in score for each successive grade (mean scores, Grades IX-XII, 8.32, 10.26, 11.96, and 11.43, respectively).

The relationship between the *ability to test hypotheses* and each of the factors, *chronological age, IQ, reading grade* and *previous terms of science,* is shown in Tables II and III, which give the simple correlations and partial correlations obtained between these factors. The statistical technique of partial correlation enables the experimenter to study the relationship between two factors while holding certain other factors constant. The effect of using partial correlations, that is, ruling out two of the variables at a time, while studying the relationship of the scores on Test II and the third variable, was to reduce the respective coefficients of correlation.

TABLE II

CORRELATIONS BETWEEN THE FACTORS STUDIED

x-variable	y-variable	For-mula	Coef. of Cor.	P.E.$_r$
Scores, Test II	Chron. Age	r_{12}	—.24	.04
Scores, Test II	I.Q.	r_{13}	.53	.03
Scores, Test II	Read. Grade	r_{14}	.57	.03
Scores, Test II	Prev. Sci. Terms	r_{15}	.22	.04
Chron. Age	I.Q.	r_{23}	—.33	.04
Chron. Age	Read. Grade	r_{24}	.02	.04
I.Q.	Read. Grade	r_{34}	.69	.02

N=259

The relationships especially to be noted are the following:

1. The correlation between the scores on the test to select procedures to test hypotheses and *chronological age,* when intelligence and reading grade are partialed out, is negative and low (—.23).

TABLE III

PARTIAL CORRELATIONS AMONG THE FACTORS STUDIED

x-variable	y-variable	Variables Ruled Out	Formula	Coef. of Cor.	PE_r
Test II	Chron. Age	I.Q.	$r_{12.3}$	—.08	.04
Test II	Read. Grade	I.Q.	$r_{14.3}$	.33	.04
Chron. Age	Read. Grade	I.Q.	$r_{24.3}$	.36	.04
Test II	I.Q.	C.A.	$r_{12.3}$	.49	.03
Test II	Read. Grade	C.A.	$r_{14.2}$	.58	.03
I.Q.	Read. Grade	C.A.	$r_{34.2}$	.74	.02
Test II	C.A.	I.Q.,R.G.	$r_{12.34}$	—.23	.04
Test II	I.Q.	C.A.,R.G.	$r_{13.24}$	.11	.04
Test II	R.G.	C.A.,I.Q.	$r_{14.23}$	.37	.04

N=259.

2. The correlation between the scores on the test to select procedures to test hypotheses and *intelligence,* when chronological age and reading ability are partialed out, is positive but negligible (.11).

3. The correlation between the scores on the test to select procedures to test hypotheses and *reading ability,* when chronological age and reading ability are partialed out, is positive and low (.37).

4. The correlation between the scores on the test to select procedures to test hypotheses and *previous terms of high-school science* is positive and low (.22).

The influence of sex as a factor in this ability was found to be unimportant (Table IV). When a group of boys and a group of girls matched for intelligence and reading ability were compared, the mean score for boys was 10.2; for girls, 8.7. The difference in means, 1.5, was not statistically significant.

TABLE IV

COMPARISON OF SCORES MADE BY BOYS AND GIRLS ON TEST II, ABILITY TO SELECT PROCEDURES

Group	N	Mean I.Q.	S.D.	Mean R.G.	S.D.	Mean, Scores Test II	S.D.	Diff. in Means
Boys	90	102.8	10.6	8.60	1.64	10.2	3.70	1.5
Girls	90	100.0	14.0	8.60	1.67	8.7	3.54	

CONCLUSIONS

The conclusions based upon the findings of this investigation *for the selected group of high-school students studied,* and *limited to the factors selected for study,* and the *evaluation instruments used* are as follows:

1. There seems to be presumptive evidence, not definitely established by this investigation, that the students' ability to *suggest* procedures to test hypotheses appears to depend, in part, upon the students' "habit of delayed response," an element of the scientific attitude.

2. Science students who have received no special training in the use of the scientific method, other than regular classroom instruction, demonstrate the ability to *suggest* and *select* procedures to test scientific hypotheses.

3. In general, students of a given high-school grade make better scores on the test to select procedures to test hypotheses than students in the grade immediately preceding.

4. Considering only the factors selected for study, the *net* relationships, as indicated by the coefficients of partial correlation, between the ability to select procedures to test hypotheses and chronological age, intelligence, reading grade and previous terms of high-school science, respectively, were not significant.

5. Girls do about as well as boys on the test to select procedures to test hypotheses.

DISCUSSION AND EDUCATIONAL IMPLICATIONS

Improvement in thinking is a recognized aim of education. In the teaching of science leading educators are agreed that the development of the ability to think scientifically and the inculcation of the associated scientific attitude are desirable objectives and should receive greater emphasis.[5] Furthermore, the great retention losses for factual scientific knowledge on the part of students, which have been revealed by research studies,[6, 7, 8] seem to imply that more attention should be given to the "intangible" objectives, particularly, training in reflective thinking which shows little or no appreciable loss.

It is not improbable that the lack of suitable measuring instruments has hampered the development of methods for training students in critical thinking. The inadequacy of the instruments used in evaluation in the past, limited in large part to tests of information and understanding, is being increasingly felt. There is a recognized need for instruments to evaluate methods of thinking and other features that influence or determine an individual's behavior.[9]

With regard to the ability to solve problems in science, this investigation has supplied further evidence in support of the assumption that problem solving involves separate abilities. This evidence is the fact that the specific ability to test scientific hypotheses does not correlate highly with such general factors as intelligence, chronological age, reading ability and previous terms of high-school science. The implication for science education is that the abilities involved in problem solving would need to be sought for as separate goals.

In the absence of norms, it is difficult to determine the degree of ability achieved by the students studied in terms of their capabilities. The mean score for the entire group on Test II, 10.26 (or approximately 50 in percentage terms) indicates that better student achievement is possible on this test. The need for the further development and standardization of tests to measure the specific abilities inherent in problem solving so as to provide suitable norms is clearly indicated.

With regard to the ability to *select* procedures to test hypotheses, it appears that regular classroom instruction does develop this ability to some extent. To what degree this ability can be improved by special methods of classroom instruction can be answered only by experimental studies. Measuring instruments, such as those constructed in this investigation, should be of considerable aid in evaluating the methods investigated.

The availability of such instruments as were used in this study should enable teachers to construct their own tests to measure problem-solving abilities. A more widespread knowledge and use of objective tests in problem-solving abilities should bring about greater emphasis in developing in pupils the highly important objective of reflective thinking since this outcome will then be measurable and hence removed from the realm of the "imponderables."

BIBLIOGRAPHY

1. Teichman, L. "The Ability of Science Students to Make Conclusions." *Science Education*, 28:268–279, Dec., 1944.
2. Garrett, H. E., Statistics in Psychology and Education. New York: Longmans, Green and Company, 1940, pp. 226–229.
3. *Ibid.* "The Arrangement of Test Items into a Scale in which the Difficulty of Each Item is Known with Reference to an Arbitrary Zero Point." Pp. 143–149.
4. *Ibid.* P. 319.
5. Report of the Commission of Secondary School Science, *Science Education* (Ohio State University) 9:490–492, Nov., 1930.
6. Tyler, R. W., "What High School Pupils Forget." *Educational Research Bulletin* (Ohio State University), 9:490–492, November, 1930.
7. Johnson, P. O., "The Permanence of Learning in Elementary Botany." *Journal of Educational Psychology*, 21:37–47, Jan., 1930.
8. Frutchey, F. P., "Retention in High School Chemistry," *Educational Research Bulletin* (Ohio State University) 16:34–37, Feb., 1937.
9. Powers, S. R., "Psychology and Methods in High School and College Science," *Review of Educational Research*, p. 66, 1938.

TEST USED IN THE PRECEDING EXPERIMENT

SCIENTIFIC THINKING—TESTING HYPOTHESES

TEST II

DIRECTIONS: *(To be read by pupils and teachers)*

This test is neither an intelligence test nor a test to see how many facts of science you know. It is rather a test to measure your ability to think as a scientist.

Perhaps you have never before taken a test of this kind. Follow the directions and do the best you can. If you come to an item you do not understand after careful study, go on to the next item. Do not spend too much time on any one exercise; answer the easier items first and go back to the more difficult items later.

It will be to your advantage not to guess. You will have plenty of time if you work steadily and do not waste your time. Read every thing in this test carefully. In this test there are fewer questions than there are in most tests, and consequently each answer is more important.

Events or situations raise problems in the scientist's mind. In attempting to solve a problem, the scientist first makes an intelligent guess based upon his knowledge as to the correct explanation of the facts which he has observed. Such a guess or temporary explanation is called a hypothesis. To determine whether his hypothesis is correct the scientist then proceeds to collect more facts by observation or experiment. He seeks to find only those additional facts which will either support or destroy his hypothesis. This procedure is called testing hypotheses.

The following is an example of what is meant:

Many persons have observed that telegraph wires sag more between poles in the summertime than in the wintertime. That is the situation, and it suggests various problems. One problem is, "Why does the wire sag more between poles in the summertime?" From your past experience, you might try to answer the problem by saying, "The heat during the summertime causes the copper wires to lengthen and therefore they sag." This answer or explanation of the situation would be called a hypothesis. *To test your explanation or hypothesis* as a scientist would, you might measure a length of copper wire both before and after heating it to see if it really does grow longer when heated.

You are to study very carefully each situation, the problem for the situation, and the hypothesis (explanation) offered to answer the problem. Then *select from among the four procedures suggested the best one that will produce new or additional facts which help to show that the hypothesis is either true or false.*

Indicate your choice of procedure by drawing a CIRCLE around the letter in front of the procedure.

EXAMPLE

Situation: Copper telegraph wires sag more between poles in the summertime than in the wintertime.

Problem: Why do the telegraph wires sag more between poles in the summertime than in the wintertime?

Hypothesis: Copper wire expands in length when heated.

Suggested Procedures:

A. Write to the telephone company to find out during what months of the year the greatest number of telephone calls are made.

B. Securely fasten a length of copper wire at both ends so that it is horizontal and stretched tight. Suspend weights of varying size from the center and measure the amount of sag in each case.

C. Carefully measure a length of copper wire. Heat it strongly. While it is hot, measure it again to see whether it has grown longer or whether it has grown shorter.

D. Observe the copper telegraph wires between ten pairs of poles to see if they all sag.

Procedure "C" is the correct answer because it is the only procedure suggested which will give additional facts concerning the effect of heat on the length of a copper wire. If it is found that the copper wire lengthens, this fact will tend to show that the hypothesis is correct. If, on the other hand, the wire remains the same or shortens, this fact will tend to show that the hypothesis is false.

In the test which follows there are some hypotheses that are true and others that are false.

1. *Situation:* A bean was allowed to germinate (start to grow) in moist sawdust and it was watered daily. It was kept in sunlight at room temperature. After a while it stopped growing and died.

Problem: Why did the young bean seedling planted in sawdust stop growing?

Hypothesis: The bean plant requires food materials present in soil but not in sawdust for continued growth.

Suggested Procedures:

A. Plant some beans in sawdust and some in sand, both of which contain no plant food. Add only water daily. Examine after a few weeks.

B. Plant several beans in a flower pot containing earth. Add fertilizer. Keep in sunlight and water daily. Observe what happens.

C. Plant some beans in sawdust, others in good soil. Keep both sets of seedlings in sunlight and water daily. Observe results.

D. Plant several beans in rich soil. Keep in sunlight and water daily. Observe results.

2. *Situation:* Milk, which spoils through bacterial action, is usually kept refrigerated.

Problem: How does refrigeration keep milk from spoiling?

Hypothesis: Refrigeration slows down the growth and reproduction of bacteria.

Suggested Procedures:

A. Fill one test tube with evaporated milk which contains no bacteria and another with fresh milk which legally may contain some nonharmful bacteria. Allow both to remain uncovered for 24 hours at room temperature. Then place both tubes in refrigerator for three days. See which sours faster.

B. Open a fresh bottle of milk and let it stand on the table for a day. See if it spoils.

C. Place one-half of a bottle of milk in a refrigerator and keep the other half at room temperature. After three days make a bacterial examination to determine the number of bacteria present.

D. Take two quart bottles of milk. Allow one to remain open to the air, the other sealed. After three days, make a bacterial examination to determine the number of bacteria present.

3. *Situation:* Ceilings are usually painted white.

Problem: Why should white be used for ceilings?

Hypothesis: More light is reflected from light surfaces than from dark-colored surfaces.

Suggested Procedures:

A. Compare the temperatures recorded by an accurate thermometer in similar rooms, one painted in a dark color, the other a light color.

B. Ask several experienced painters why they paint ceilings white.

C. Hold a dark-colored and a white surface at the same distance from a light. Measure the intensity of the light reflected from each surface.

D. Use a prism to analyse the light reflected from a white ceiling.

4. *Situation:* Green vegetables contain vitamin C. If bicarbonate of soda (baking soda) is added to green vegetables in cooking, the vegetables keep their green color. It is claimed, however, that the soda destroys the vitamins.

Problem: If one wishes to keep the vitamin C in the vegetables, should bicarbonate of soda be used?

Hypothesis: Vitamin C is destroyed by boiling with bicarbonate of soda.

Suggested Procedures:

A. Boil several different green vegetables in water containing bicarbonate of soda. Examine the vegetables and observe how green the vegetables are.

B. Divide a litter of guinea pigs into two groups. Feed both groups a diet that lacks vitamin C. Add to the diet of group 1 green vegetable cooked with bicarbonate of soda. Add to the diet of group 2 green vegetables cooked without bicarbonate of soda. After a few weeks examine the guinea pigs for signs of bad effects due to the lack of vitamin C.

C. Dissolve a Vitamin C tablet in water and boil the solution for one hour. Feed this solution to a guinea pig suffering from scurvy, a disease resulting from the lack of vitamin C. Observe whether the guinea pig's condition improves.

D. Divide a litter of guinea pigs into two groups. Feed one a normal diet including uncooked green vegetables. Feed the other group a normal diet containing green vegetables cooked in plain water. Observe whether scurvy develops in any of the guinea pigs.

5. *Situation:* A boy lifted a heavy rock from a river and found that just as it cleared the surface of the water, it seemed to get heavier.

Problem: Was the boy misjudging the weight of the rock?

Hypothesis: Objects appear to weigh less when submerged in water than in air.

Suggested Procedures:

A. Tie a stone to a string attached to a hand scale. Note the weight of the stone. Then suspend the stone below the surface of the water and note its weight.

B. Weigh a glass of water on a scale. Also weigh a stone and then gently drop it into the water. See whether the glass, water and stone together weigh less than the glass of water plus the weight of the stone in air.

C. Weigh a stone by suspending it in the air. Place it in water and then remove it. Weigh the wet stone to see if it is lighter.

D. Tie a stone to a long string attached to a hand scale. Lower the stone to a depth of two feet. Gradually lift the stone. While the stone is still submerged note its weight at different levels as it is raised.

6. *Situation:* When reading in a room lighted only by a single table lamp it is necessary to sit quite close to the lamp.

Problem: Why must one sit close to the lamp for comfortable reading?

Hypothesis: The amount of light falling on a book decreases rapidly as one moves away from the lamp.

Suggested Procedures:

A. Measure the brightness of the light reflected from the book at various distances from the lamp.

B. Holding the book at the same distance from the lamp, compare the brightness of the page when you are (1) facing the light, (2) facing away from the light.

C. Seat a person in a dark room and notice how the pupil of his eye changes as the light intensity increases.

D. Remove the lampshade and notice the effect on the brightness of the room.

7. *Situation:* A lima bean was planted in good soil and watered daily. After several days the bean appeared above the surface. It split in two, and from the center there appeared two new leaves. After a while, as the leaves grew larger and became green in color, the two original halves of the bean seed began to shrivel and dry, and eventually fell off the plant.

Problem: Of what use are the two halves of a bean seed to a young bean plant?

Hypothesis: A bean seedling gets its first food from the two halves of the bean seed.

Suggested Procedures:

A. Plant about 10 lima beans in moist sawdust contained in two boxes. Water daily. Keep one box in strong sunlight, the other in the shade. After three weeks compare the two sets.

B. Plant about five lima beans in soil and about five in moist sawdust. Water each set daily. Compare the two sets after several weeks.

C. Plant a lima bean in good soil and water it. Plant another bean in good soil but do not water it.

D. Plant about ten lima beans in moist sawdust. Water them daily. As soon as the beans appear above the surface, cut off the two halves of the bean seed from half of the seedlings. Compare the two sets of plants after three weeks.

8. *Situation:* The manufacturer of a certain facial cream claims that his product, which contains vitamin D, supplies the body with an additional amount of this vitamin.

Problem: Would it be wise to use this cream as an extra source of vitamin D?

Hypothesis: Vitamin D can be absorbed through the skin.

Suggested Procedures:

A. Select three healthy white rats and keep all of them in a darkened room. Feed the first rat a diet that contains a sufficient supply of vitamin D. Feed the second rat a diet containing no vitamin D. In addition, shave a measured area of the skin of the second rat and apply the facial cream daily. Feed the third rat a diet lacking vitamin D. After four weeks examine the rats for bad effects due to lack of vitamin D.

B. Select two healthy white rats. Feed one a normal diet containing vitamin D. Feed the other a diet that lacks vitamin D, but mix in some of the facial cream with the rat's food. Watch for bad effects due to a lack of vitamin D.

C. Put some of the facial cream on the face and see if it disappears after a while, thus indicating that the cream containing the vitamin was absorbed by the skin.

D. Have a selected group of women use the facial cream and after two weeks ask each one whether any good effects were noticed.

9. *Situation:* A goldfish was removed from an aquarium and placed in water which had been previously boiled and cooled to room temperature. The fish soon died.

Problem: Why is water which has been boiled and cooled to room temperature unfit for fish to live in?

Hypothesis: When water is boiled it causes the dissolved gases to escape.

Suggested Procedures:

A. Pour the contents of a bottle of very cold soda pop into a glass. Observe the escaping bubbles of gas.

B. Pour some water from the cold-water faucet into a glass. Into another glass, pour freshly boiled water which has been allowed to cool. Notice in which case gas bubbles collect on the inside of the glass after the glasses have been allowed to stand for some time.

C. Boil some water and while the water is still boiling, hold a lighted match over the pot. See if the match flares up because of escaping oxygen.

D. Place a goldfish in cool water. Place another goldfish of the same size in water at least ten degrees higher. See what happens to the fish.

10. *Situation:* Visiting an old clock shop one day, a boy noticed that the pendulums of the clocks were of different lengths and were swinging at different rates.

Problem: Why were some pendulums swinging faster than others?

Hypothesis: The rate at which a pendulum swings depends upon its length.

Suggested Procedures:

A. Start a long and a short pendulum swinging. See whether the longer pendulum makes longer swings.

B. Take two clocks with pendulums of different lengths. Set both clocks and see whether they keep the same time.

C. Fasten two strings of equal length to each of two weights, one of which is twice as heavy as the other. Set them swinging and count the number of swings that each makes in one minute.

D. Make a pendulum by fastening a string to a stone. Set the pendulum swinging and count the number of swings per minute. Shorten the string to one-half its original length and again count the number of swings per minute.

11. *Situation:* One end of a glass rod and one end of a silver spoon were placed in a pan of boiling water. After a minute the spoon was too hot to touch while the glass rod could be picked up easily.

Problem: Why did the spoon get very hot while the glass rod did not?

Hypothesis: Heat travels more rapidly in metals than in other materials.

Suggested Procedures:

A. Boil any metal and a piece of glass in water. Remove and take the temperature of each.

B. Place objects made of different materials including several metals in strong sunlight. After several hours feel each to see which is hottest.

C. Select several rods of the same size and length, but of different materials, e.g., glass, copper, iron, wood, etc. Place a lump of wax at one end of each rod. Heat the opposite ends over a hot electric stove. Compare the time taken for the wax to melt on each rod.

D. Pour hot tea into each of two glasses. Place a silver spoon in one of them. See which glass of tea cools faster.

12. *Situation:* Salt is sometimes spread on icy pavements in winter.

Problem: Does salt help to melt the ice?

Hypothesis: Salt lowers the temperature at which water freezes.

Suggested Procedures:

A. Spread salt on an icy pavement, and notice whether the salt sinks into the ice.

B. Take the temperature of a glass of cold water. Pour salt into the water, stir and take the temperature again.

C. Take an ice cube from your refrigerator. Put it in a plate and sprinkle salt on it. See what happens.

D. Fill two refrigerator trays with water. Dissolve a tablespoon of salt in the water of one tray. Place both trays in refrigerator and note the temperature at which each tray freezes.

13. *Situation:* On a humid day when the air is filled with invisible water vapor, wet clothes on a clothesline do not dry very well.

Problem: Does the evaporation of water from wet things decrease on a humid day?

Hypothesis: High humidity tends to prevent further evaporation.

Suggested Procedures:

A. Thoroughly wet two pieces of cloth of the same size. Place one in an open jar, the other in a tightly closed jar. Observe which dries more rapidly.

B. Place equal amounts of water in two beakers. Heat one beaker gently over a bunsen flame, but do not boil. Keep the other at room temperature. After three hours measure the amount of water left in each case.

C. Hang clothes to dry on a cool day and on a hot day. Observe the results.

D. Place equal amounts of water in a shallow basin and in a narrow-mouthed bottle. After several days determine the rate of evaporation by measuring the amount of water left in each case.

14. *Situation:* In an effort to shorten the time necessary to cook some potatoes the gas was turned up after the water had started to boil.

Problem: What effect does turning up the gas have on the temperature of boiling water?

Hypothesis: Turning on more gas raises the temperature of boiling water.

Suggested Procedures:

A. Heat some water in a vessel until it begins to boil. Then turn up the gas and notice whether the water boils faster.

B. Put two pots filled with the same amount of water on the gas stove. Turn up the gas under one pot, but have a small flame under the other. Observe in which case the water begins to boil sooner.

C. Boil some water over a low flame and record the temperature. Add a teaspoonful of salt and note the temperature again.

D. Heat some water in a vessel until it begins to boil. Take the temperature of the water. Turn up the gas for a while and then take the temperature again.

15. *Situation:* All the leaves of a geranium plant on a window sill seemed to be facing outdoors.

Problem: Do leaves turn to face the sun?

Hypothesis: The leaves of plants turn towards the sunlight.

Suggested Procedures:

A. Select a few geranium plants and place them on a window sill. After a few days observe the position of the leaves.

B. Place as many different kinds of plants as possible on a window sill. After a few days observe the position of the leaves. Turn the plants and observe again after a few days.

C. Observe the leaves on a tree growing in an open field. Determine the position in which most of the leaves face.

D. Place one geranium plant in a room illuminated only by two electric lamps in opposite corners of the room. Place a similar geranium plant in a dark room. After a few days observe the position of the leaves.

16. *Situation:* The temperature of the air near the ceiling of a room was three degrees higher than that of the air near the floor.

Problem: Why was the warm air near the ceiling?

Hypothesis: Warm air rises.

Suggested Procedures:

A. Take two bottles of equal weight but not of equal volume. Fill the larger one with warm air, and the other with cold air. Then weigh both flasks to see which weighs more.

B. Gently drop small bits of tissue paper over a hot stove or radiator and also in other parts of the room. Observe what happens.

C. Compare the temperature recorded just outside a window of the top floor of a tall building with the temperature recorded at street level.

D. Take the temperature of the air in a

room in which the shades have been drawn and compare it with the temperature of a room in which the sun has been shining for several hours.

17. *Situation:* Common salt, sodium chloride, belongs to a group of substances called chlorides. When a solution of salt is mixed with silver nitrate a white substance called silver chloride is formed.

Problem: Do other chlorides also form silver chloride when treated with silver nitrate?

Hypothesis: Other chlorides treated with silver nitrate form a white substance, silver chloride.

Suggested Procedures:

A. Add silver nitrate to an unknown solution. Silver chloride will form only if a chloride is present. Observe results.

B. Into each of two test tubes place a solution of salt. Add silver nitrate to one of the tubes, but not to the other. Observe results.

C. Prepare two solutions, one of salt, the other of granulated sugar. Add silver nitrate to each. Observe results.

D. To as many different chloride solutions as are available add silver nitrate. Observe results.

18. *Situation:* In purchasing dress materials in a store illuminated by electric lights, a customer took samples of the material to the window to examine the colors in daylight. The colors were not quite the same shade.

Problem: Why do colored objects appear different when viewed in sunlight and in artificial light?

Hypothesis: Artificial light and sunlight differ in their color make-up.

Suggested Procedures:

A. Examine the same piece of cloth under an ordinary electric light, a fluorescent lamp, and a neon lamp.

B. Examine sunlight and artificial light through a spectroscope, an instrument that analyzes light.

C. Compare the brightness of artificial light with that of sunlight.

D. See whether colors can be seen more distinctly in sunlight than in artificial light.

19. *Situation:* Some farmers kill hawks because they believe hawks prey upon chickens.

Problem: Do all hawks kill chickens?

Hypothesis: Hawks are harmful to man because they kill chickens.

Suggested Procedures:

A. Protect the chicken coops with chicken wire to keep the hawks away.

B. Capture a live hawk. Feed him well and then place him in a yard with chickens. Observe what he does.

C. Capture many hawks in the vicinity where chickens have been attacked. Examine the contents of their stomachs to see what they have been eating.

D. Call a meeting of farmers and decide whether hawks are harmful by a majority vote.

20. *Situation:* Aviators who fly above 40,000 feet dress warmly.

Problem: How does the temperature of the air vary with altitude?

Hypothesis: The temperature of the air decreases as you ascend into the air.

Suggested Procedures:

A. Examine records of temperatures recorded at various altitudes. Prepare a table showing the relationship of temperature to height above the ground.

B. From air samples taken at various altitudes, prepare a table showing the relation of altitude to per cent of oxygen.

C. Prepare a report on air temperatures based upon the personal experiences of test pilots.

D. On a warm summer day, record the temperature in a room on the first floor, and also in a room on the top floor of a tall building.

THE "NEW" SCIENCE: SHALL *WE* DECIDE WHAT TO TEACH?

ALEXANDER FRAZIER
Secondary Curriculum Coordinator, Los Angeles County Schools

TODAY, with science at once the object of public wonder because it seems to promise in peace the fulfillment of mankind's greatest dreams about power and plenty, and the object, as well, of public gratitude because it has contributed so consistently and finally so climactically to our success in war, we might suppose science education to hold a highly enviable position. As far as public acclaim and interest are concerned, it does; but science education in secondary school is far from comfortable. How can it educate for the production of more and even abler scientists and at the same time meet what is sure to be an increasing clamor for popularization of its subject matter?

This dilemma, while by no means new

in the literature of science education, is pointed up by the fact that the force that is to clamor for popularization is not merely a liberal group within the teaching profession, as it has been in the past: it is now the patrons of the schools themselves. "Does it not seem that the tendency of science is now from hard figures and marrowless particulars, dead analysis, back to synthesis," asked Emerson, with perhaps undue anticipation, in his *Journal* for 1836; "that now Ideology mixes therewith; that the education of the people forces the *savant* to show the people something of his lore which they can comprehend . . . ?" Climaxed by the thunder of the atomic bomb, the education of the American people under four years of almost daily miracles from science has induced in them what threatens to be an insatiable curiosity; it has prepared them on a national scale to demand answers to their questions. Can we doubt that there is to be on the part of the oncoming generation of secondary school students an anticipation, as on the part of parents there will be an expectation, of their understanding what all this furor about science really signifies?

Nor, on the other hand, is the force that will urge us to raise our standards to be made up solely of the die-hards within the profession who have felt that as the millions of "non-academic" students have poured into our secondary schools, we have been guilty of letting down the bars in science education. They have already been joined by the armed services, which during the war years were highly vocal in their demand for a more specific training to meet wartime needs, a new kind of training if not a better, and which will continue to exercise great authority if universal service comes. To them, we may expect the addition of pressures that will arise from federal encouragement of science training and research, if that develops as it now promises under the recommendations of the Bush report.

Thus the struggle between the liberal, with the public behind him, and the reactionary, with support from the armed services and potentially from other federal sources, reaches a climax about which the school will have difficulty in doing nothing. The school must act. Unless he is willing to await passively the development of a policy through administrative expediency, the science teacher himself must act—and the sooner, the better. Perhaps a brief description of the key issues upon which he will have to take a stand if he is to be effective may be of some value at this time.

Although a choice of such issues will depend upon where a particular school is in its present science program, we may assume that the science teacher who agrees to find a challenge in the current situation and to accept it will find it necessary to consider at least the problems of providing for new student interest and new student need, of guiding the prospective student in choosing wisely where alternatives exist, and of meeting adequately the new community interest in science.

How are the student interest in science and the new student need to be met? Not all schools will reach the same conclusions, we know, when they come to consider this issue. But it is necessary for them to define their position, whatever it is to be. In general, it would seem that schools should discuss and formulate their convictions on such questions as these:

- What does the student need to know about science to behave intelligently in the new world?
- Can this need be met in the regular science courses in our particular school? If so, what may we need to add or modify?
- Or do we need to reconstruct our entire science offering in order to meet the new needs of our students?
- What science should be required of all students? In what sequences?
- What is the relationship between college needs and the new science education as we see it?

From what we know of present practice and theory, we may anticipate that the answers to these questions will be made within one of the following three "philosophic" frameworks: (1) the double track program, with generalized, non-laboratory

courses for the "lay" student and the customary specialized sciences for the pre-professional; (2) the "double layer" program, with beginning courses in life and physical sciences required of all students before the specialized upper-division courses are available to any and these latter courses to be available only to students who are definitely of academic bent; and (3) the generalized science curriculum with a required sequence for all students, regardless of ability.

The difficulty in working out answers to the previous questions within any of these frameworks will vary according to whether the slant is toward modifying the present courses or whether it involves wholesale reconstruction. In any case, the school and the science department must know what their answers are to be to the inquiries of interested agencies; they must be ready to make their answers clear to all and as widely acceptable to all as their philosophy of science education will admit.

How is guidance to be provided so that the right students will get into the right courses? Naturally if the school decides to have all the students take all the science courses, this problem will take care of itself. However, should there be set up, as is more likely, either a double track or a "double layer" program, then the problem of directing students into the proper channels becomes acute. The success of a differentiated program depends directly upon success in selling the program to out-of-department teachers, to students, and to patrons.

Faculty understanding cannot be taken for granted. Ideally the process of revision or reconstruction will have begun with the entire faculty; but whether it has or not, teachers of the science department must see to it that the ends they propose are thoroughly understood and as widely accepted as can be among their co-workers. Such education should not be confined to a general announcement at one of the monthly faculty meetings; it requires time and persistence to gain acceptance for a new philosophy or a new viewpoint. Whatever is done should be followed up, particularly at registration time. Bulletins and personal conferences for *teacher* counseling may be necessary.

However successful teacher education may be, student understanding of the new aspects of the science program should not be left to the good offices of the counselor alone. A planned campaign of student information should be instituted. School publications and assemblies, as well as direct contact with students already enrolled in science courses, can be used to make sure that the objectives and scope of the science program become familiar.

The same approaches and some of the same material can be directed at the third public relations "front," that of the parent and patron. Unless the adult population understands the purposes of the program, it is almost bound to meet the resistance of non-comprehension. Parent-Teacher's Association, service clubs, and women's groups will all be interested in learning what the school is attempting to do with the new science; some of these might well be given the opportunity to examine and approve the program before it goes into effect, if it is one that involves many changes.

How is general community interest in the "new" science to be met? The adult population of the community is interested not only in being assured that its children are to have a better education in science than it had; it has itself great curiosity that it is busy satisfying by whatever means come to hand. We may discount in part, if we will, the thirst for meaning that the public displays; we may smile at the almost indecent self-glorification on the part of some of the reputable institutions connected with the Manhattan project as they hasten forward to explain the new age—and their part in it. But there is undeniably a legitimate

interest in the social implications of atomic power that secondary school science education ought properly to take into account.

Although the successful "promotion" of community understanding of the school's science program is the first of the ways in which interest should be met, there are still other possibilities open to a lively department. Among them, we may list:

Student panels and exhibits. Science Club members or regular science students might prepare programs for community groups on such topics as "Science and the World at Peace," "Science of the Atom," and "Science and Plenty," perhaps with charts or slides for illustration.

Teacher lectures. If the department is fortunate in having an able speaker among its members, it should have little trouble in securing a place for him on the program of one of the civic clubs, after which he should receive more invitations than he can accept, since good speakers on interesting topics are usually in wide demand before such groups.

Radio programs. Student panels and teacher speeches, of the sort already suggested, can reach larger audiences through the facilities of local radio stations, which might even be willing to cooperate in a science series, perhaps one involving questions submitted by listeners. Recordings of such programs could be made and offered to club groups.

School publications. Patrons can become aware of the interest of the school in science education through editorials and articles in the school newspaper and through a scientific theme as developed in the school magazine or yearbook. In addition, mimeographed or printed bulletins on the ways in which the school is meeting the demand for a newer science education can be prepared, perhaps in cooperation with journalism classes, for distribution to patrons.

Adult classes. Night school courses in "atomic" physics or the social implications of the new science might well prove of some popularity in systems large enough to offer a variety of classes. If the school feels that a series of three or four forums on science and the future would be welcomed, it can probably draw in from the community able persons to assist in panel discussions.

With the new interest and need of students taken care of, with guidance provided so that the new aspects of the program will succeed, and with such provision for meeting community interest as can be made, the science teacher should not have to fear imposition of ill-considered solutions from above or without. Such assurance does not mean that the science teacher can rest; in the years immediately ahead, secondary school science, whatever the scope proposed for it by the individual school, is bound to be under a new scrutiny by powerful groups within the population as well as by the public itself, as we have pointed out.

Science teachers who wish to maintain control over the setting of their objectives must understand that a continuous modification of their curriculum is required for success in meeting changing needs. If secondary school science education is responsive to these needs, there is no reason why it should not be entering a new era of significance; if it is not, it may find itself no longer able to make decisions of any kind about its future.

ENRICHING THE HIGH SCHOOL SCIENCE CURRICULUM

WILLIAM E. WARD
Fort Worth-Handley High School, Fort Worth, Texas

TODAY education is being thought of in terms of a rich experience. The school is an agency for education and education may be defined as a process by means of which the pupil realizes his potentialities and increasingly becomes an intelligent individual and an efficient, cooperative member of society. In order to achieve such a result the school experiences of the child should be such as would build up a comprehensive understanding of those major generalizations which are significant in everyday life.

Formerly the curriculum was thought of

as a body of material which was organized for the pupils to study and recite. The curriculum was found almost entirely in the textbook. The present day concept of the curriculum is much more comprehensive. Today the curriculum is thought of as being made up of all of the experiences which the pupil has under the supervision of the school and the teacher. Obviously, from this new concept, the curriculum includes much more than the "what" of education. In addition to the "what" it is equally concerned with the "why" and "how" of education. Therefore, a curriculum revision program also concerns itself with objectives and methods. The objectives will be based upon the educational philosophy. The major objective is that of achieving changed behavior. The direction this change should take is indicated by the objectives set up. The "what" of education should be determined on the basis of the needs and interests of the pupils. The "how" of the education should be determined on the basis of the best educational psychology.

The pupil interests should be "capitalized on" or taken advantage of by the teacher and directed into pupil activities leading to the achievement of the objectives set up. While in the process of carrying out these activities the pupils experience certain needs—felt needs. These are then directed toward achievement of the objectives by the teacher. However, it is perhaps the prime function of the teacher to so guide the pupil activities as to cause certain adult needs to become felt pupil needs. This, then, will result in a higher degree of achievement of the objectives. Of course, the objectives should always be kept in mind by the teacher and serve as immediate goals to be reached or as signposts along the highway to the ultimate goal of the highest type of growth and development possible.

In attempting to meet these responsibilities, schools are trying many new methods and procedures. Hundreds of new courses of study have been written and revised throughout the country. Activity programs have been set up. Experimental schools have been established. All of these things—and more—have been done in an effort to enrich the curriculum so that the school experiences of the child may be made more meaningful and functional.

The possibilities for enriching the curriculum are almost unlimited. The alert teacher has a vast store of materials at her finger tips, so to speak, upon which she may call to enrich the curriculum. A few of these possibilities are merely mentioned here, which may serve as suggestions. There are many community sources. Lay leaders are often glad to make talks to groups on their particular specialties. Fire departments are only too glad to have their members discuss the operations of the department for the purpose of developing a fire-prevention program. Traffic officers are usually anxious to cooperate similarly. Architects, doctors, etc., may often contribute much in this way. Business men and industrialists take pleasure in having classes make excursions or field trips to their establishments where they may observe the various processes being carried on in actual life situations. Motion pictures may be used very effectively for enrichment, primarily because of the "interest" factor. Literature, especially fiction, magazines, and the newspapers will serve as a valuable source of enrichment materials. Naturally the teacher must use a great deal of good judgment and "common sense" in selecting the materials used.

In practically every phase of our modern life changes are constantly being brought about through science. New inventions result in new ways of life. Changes in ways of living bring about social changes. Socio-civic and socio-economic relations undergo changes. We must understand these changes and their causes in order to grow into intelligent individuals and intel-

ligent, cooperative members of society. In a word, we must keep abreast of the times in order to fit into our changing world most effectively.

That this is of great significance to the science curriculum is obvious. With our present day educational philosophy based upon the concept of complete growth of the whole child the importance of, and the need for scientific knowledge is unquestioned. World War II has forcefully demonstrated the importance of scientific knowledge. An understanding of the basic scientific laws and principles is essential. But the paramount issue is, very probably, the recognition of the social significance of science. The teacher should most certainly strive to make the scientific knowledge meaningful and functional in the lives of the pupils. The ultimate purpose of our schools is the training of boys and girls so that they may have the ability to adapt themselves and adjust themselves to conditions of their environment in a way which makes for the happiest and most useful life—that is, in a way which is in the interest of the general welfare. Since science is so obviously one of the basic influences of present day society, each one of us is handicapped without an understanding of the social significance of the fundamental science concepts.

For these reasons the resourceful, understanding teacher will be on the alert and be ready to take advantage of every opportunity, and make use of every device possible in an effort to make the science information meaningful and functional in the lives of the pupils. This type of teaching is essential to the development of an enriched curriculum.

Most school librarians would be happy to cooperate with the science teacher in preparing a list of annotated books and periodicals which would be useful in enriching the science curriculum. Such a list should be kept up-to-date as new materials come off the press.

By means of an example the writer has attempted to illustrate how these sources of enrichment may be utilized. This example is in outline form and is represented as being merely suggestive. It is very flexible and may be adapted and supplemented to meet specific needs.

ILLUSTRATIVE EXAMPLE

Class—High School Biology.

Problem—The physiology of the heart and lungs, the respiratory and circulatory systems.

Time—The usual amount of time devoted to this problem, or more, if the interests and needs of the pupils indicate that they could use more time advantageously.

Method—The methods generally employed plus the use of an abundance of enrichment materials.

Justification

1. Pupil interest which may be made the basis of much pupil growth.

2. An excellent opportunity to study the subject matter in terms of its social significance.

3. Opportunity to make adult needs become pupil needs and thus increase interest and desire for learning.

Objectives

1. To develop an appreciation for scientific knowledge.

2. To help the pupil understand the social values of science.

3. To show the pupil how he may use scientific knowledge to improve his own conditions as well as those of the group.

4. To create in the pupils a tolerant, helpful, sympathetic attitude toward persons less fortunate than they.

5. To learn about the respiratory system and circulatory system and how they function.

6. To see the real need for the value of this knowledge.

7. To give the pupil a scientific attitude and appreciation of the scientific method.

Activities

These are suggestive. Many more might be added. The teacher should select those that meet the local needs and add others which will be more appropriate for local conditions.

1. Make the usual assignments in the textbook and reference books.

2. Urge the pupils to read "The Citadel," by A. J. Cronin.

3. Look ahead and arrange with the management of a local motion picture theater to have "The Citadel" shown during the time when this work is being done by the class. Many motion picture theaters have "Revival" nights and are happy to bring old pictures back for a return showing if there is sufficient interest.

4. Urge the class to see the motion picture, "The Citadel."

5. Discuss the picture in class.

6. Discuss the book "The Citadel" in class. Emphasize the parts of the story relating to science.

7. If in a mining district take the class to visit a mine.

8. While discussing the story, use charts of lungs, bronchial tubes and trachea and point out the parts affected and discuss causes and relationships.

9. Write to the State University for a motion picture on the physiology of these systems and show the picture to the class. Most State Universities have on hand good motion pictures which are loaned to public schools.

10. Have pupils give reports on the social value of the picture from the point of view of science.

11. Have pupils give reports showing how science has improved man's conditions.

12. Discuss in class, the value of the scientific knowledge involved.

13. Show a picture of a mine and discuss conditions therein.

14. Discuss tuberculosis; how the bacteria cause the disease; the care, treatment, etc.

15. Discuss the methods of the scientist and illustrate by referring to various incidents in the story.

16. Make a drawing of the circulatory system, ink it in with black India ink, and label the parts.

17. Make a drawing of the respiratory system, ink it in with black India ink, and label the parts.

18. Discuss pneumonia as to cause, condition of affected parts, etc.

19. Invite a doctor of medicine to talk to the class about the importance and care of the heart and lungs.

20. Have a demonstration of artificial respiration and explain the procedure.

21. Invite a member of the fire department to show a pulmotor to the class and explain how it works.

22. Have the pupils write a paper discussing the value of scientific knowledge.

23. Fit up a bell jar with a one-hole rubber stopper, a "Y" glass tube, and two toy rubber balloons. The inverted "Y" tube represents the trachea and the bronchial tubes. The balloons are attached to the two ends of the tubes. The third end extends up through the rubber stopper. Then, stretch a sheet of thin rubber over the bottom of the bell jar, making it fast. The bell jar now represents the chest cavity and the balloons are the lungs. Now push in and out the sheet rubber and the lungs will inflate and deflate, thus representing the action of the diaphragm and the breathing process.

24. Point out the circulatory system on a chart and explain the functions of the heart, arteries, veins, and capillaries.

25. Discuss the relation of the circulatory system to the respiratory system.

26. Point out the necessity for harmony between all parts of the body in order to maintain normal health.

27. Demonstrate a model heart to the class, explaining the pumping action.

28. Show how valves in the veins keep the blood always flowing in the same direction through the circulatory system.

29. Have pupils bring to class and read newspaper stories of the use of the "iron lung."

30. Explain how the "iron lung" functions.

31. Discuss the process of breathing and explain how oxygen is inhaled into the lungs, where it is taken up by the red corpuscles and carried by the blood to all parts of the body.

32. Explain how waste material is oxidized and the carbon-dioxide is carried to the lungs where it is exhaled.

33. Explain why we breathe rapidly when exercising.

34. Tell the class about the experiment made on two practically identical dogs, in which one of the dogs is made to run until it is tired while the other dog is permitted to rest. A double blood transfusion is then performed on the two dogs. The blood of the rapidly breathing dog is caused to flow into the blood vessels of the rested dog while that of the rested dog is run into the blood vessels of the dog which has been running. As soon as this is accomplished the dog which has been resting begins to breathe rapidly as if he had been exercising vigorously, while the dog which has been running stops panting and seems to be perfectly rested. Explain the reason for this to the class.

35. Discuss and demonstrate oxidation.

36. Demonstrate the test for carbon-dioxide.

37. Test exhaled air for carbon-dioxide.

38. Explain how oxygen is inhaled into the lungs, gets into the blood and oxidizes the waste materials to form carbon-dioxide which is exhaled.

39. Discuss the relationship between the digestive tract (which was previously studied), the respiratory, and circulatory system. Review the process by means of which food gets into the blood stream. Then explain how oxygen gets into the blood and how the food is oxidized to give energy.

40. Discuss carbon-monoxide and how miners test for its presence.

41. Have pupils report on silicosis.

42. Explain why the heart beats more rapidly when one is more active.

43. Have a class discussion of the scientific method.

44. Point out the importance of getting all of the facts first and drawing conclusions on the basis of these facts.

45. Read parts of "The Citadel" or other appropriate stories in class and discuss this material in regard to the science implications and their social significance.

46. Have the pupils write a paper on the social significance of science.

GENERAL PHYSICS AND MODERN ELECTRICAL COMMUNICATION *

REUBEN BENUMOF
McKee Technical High School, New York, New York

RELATIONSHIP OF PHYSICS TEACHING TO RECENT COMMUNICATIONS DEVELOPMENTS

BEGINNING about 1932, a number of developments occurred which profoundly influenced electrical communication. According to Keith Henney,

In 1932–1933 when the tubes with dome-shaped top were developed, new possibilities for waves of the order of 5 meters were opened up. Prior to this time much difficulty was experienced in making stable oscillators at waves of 5 meters or somewhat above, and amplification at such wavelengths was impossible. The dome-shaped tubes, however, with smaller elements and better shielding made possible efficient operation at 5 meters.

In 1933, other very interesting developments took place. B. J. Thompson described before the Institute of Radio Engineers work he had carried on for months leading toward the manufacture of

* An abstract of a study with the same title made in partial fulfillment of the requirements for the degree of Doctor of Philosophy at New York University.

tubes especially designed for ultra-short-wave work.[1]

J. C. Slater states that "the development of microwave technique may be said to date from the adaptation of hollow pipes and horns to microwaves" [2] which was carried out prior to 1936. This was followed by the development of cavity resonators by Hansen, Condon, and others. In later years, other advances were made which were so impressive that Keith Henney believes that "developments during 1940 and later years, instigated by military requirements will call for a vast readjustment of the communication system." [3] A modern development in electrical communication will therefore be construed in this paper as one occurring since the year 1932.

Effective communication with others is a highly important problem of living in a modern democratic society. There seems to be wide acceptance of this idea among leading educators. Bobbitt,[4] for instance, considers language (social intercommunication) as one of the ten great fields of human activity. The Educational Policies Commission states, "A mastery of the various arts of using one's own language is the most universal of all educational objectives."[5] And as one more example, Carleton Washburne says, "To foster and facilitate effective communication is one of the basic functions of education."[6] Thus, it would seem reasonable to state that science education, as a significant part of general education, ought to make notable contributions in leading students to realize the nature and extent of the problem of how to communicate with others and to understand the progress that has been made in solving this social and scientific problem.

Assuming the validity of this point of view for general education, it is apparent that, in order to be effective, courses in physics should be adapted to changing conditions caused by modern developments in this field. According to Slater,

> Electrical communication has been carried on at ever-increasing frequencies. The progress has been from audio frequencies to radio frequencies, to short waves, and now to the range of waves called microwaves; wave lengths perhaps in the range from a half meter to a few centimeters. The progress has been an orderly one, with few new principles needed for its understanding, until the latest step; but microwaves are so different in many ways from longer waves that a new technique is needed, a technique that comes more naturally to the physicist trained in Maxwell's equations than to the electrical engineer trained in electric circuits.[7]

Further, Beverly Dudley, acting manager of *Electronics*, says,

> Electrical communication is playing an increasingly important role in the present war. It has often been said that the present war is a physicist's war. Certainly the armed forces are making every possible use of the developments which those physicists and engineers have devised for peace-time communication methods. The technical complexity of the communication equipment now in use by the armed forces demands that the designers and even the operators be thoroughly versed in the fundamentals of electricity and communication engineering, especially with regard to the uses and applications of the multitudinous types of electron tubes.[8]

The United States Office of Education also seems to be in accord with this point of view for it has sponsored in local colleges and universities tuition-free War Training Courses in modern electrical communication in order to provide supplementary training for those who had not been able to keep up with the recent advances made in this field. It appears, then, that it is important that modern developments in electrical communication be treated to some extent in courses in physics for general education. Consequently, it is desirable to determine to what extent this is being done.

PURPOSE OF THE STUDY

The purpose of this study was to determine the actual and desired extent of treatment of modern developments in electrical communication in elementary physics courses. In order to do this adequately, it was necessary to investigate the following four subsidiary problems: (1) to determine what the modern developments in electrical

communication are, (2) to determine the extent to which these developments are treated in elementary physics courses, (3) to estimate the desirability of including a treatment of the modern developments in elementary physics courses, (4) to analyze the modern developments in terms of basic ideas or concepts and to show the relationship between these ideas or concepts and those usually included in the elementary physics course. A modern development was defined as any change in the theory or practice of communicating by means of electromagnetic waves occurring since the year 1932.

THE PROCEDURE

In order to determine what the modern developments in electrical communication are and subsequently to describe them in terms of basic ideas or concepts, an analysis was made of all of the issues of thirty-one important technical periodicals published since 1932. The analyses of the articles in these journals were grouped under three headings: namely, (1) those concerned with some aspect of the general problem of communicating by means of electromagnetic waves; (2) those concerned with some specific technique involved in electrical communication; and (3) those concerned with some new general method of electrical communication involving new applications of old techniques or applications of new techniques. A tentative list of the modern developments in electrical communication was then drawn up. This list was checked and refined by analyzing, in addition, a number of advanced college textbooks and special publications concerned with some aspect of electrical communication. This list was further checked and refined on the basis of suggestions made by a small group of experts in the field.

The present treatment of the modern developments in elementary physics courses was investigated by analyzing ten high school textbooks on physics, fourteen college textbooks on physics, and six college orientation science textbooks, all published since 1938. An inquiry blank addressed to one hundred eighty high school teachers of physics, fifty college teachers of physics, and seventeen professors of science education was also used. Seventy usable replies were received from the high school teachers, twenty-eight from the college instructors, and fourteen from the professors of science education. This same questionnaire was employed, in addition, as a means of determining the recommended treatment of the modern developments in the elementary physics course.

An analysis was made of the modern developments in terms of basic ideas or concepts. The relationship between these ideas or concepts and those usually treated in elementary physics courses was indicated and suggestions for teaching this material were made.

THE RESULTS

By following the procedure described above, the list of modern developments in electrical communication given below was obtained.

GENERAL DEVELOPMENTS

1. The rationalized Giorgi system of units, in which the meter, kilogram, and second are the basic units of length, mass, and time, has emerged as the simplest system for use in electromagnetic calculations.

2. Maxwell's electromagnetic field theory, rather than circuit theory, is being used to solve modern problems, necessitating a redefinition and extension of the concept of impedance.

3. The propagation of electromagnetic waves of various frequencies in the form of ground and sky waves has been investigated experimentally and theoretically, resulting in increased knowledge of the ionosphere.

NEW TECHNIQUES

4. New methods of generating electromagnetic waves have been discovered, mak-

ing possible commercial application of hitherto unused portions of the frequency spectrum.

5. New types of resonant elements, such as cavities with conducting walls or quarter wavelength sections of parallel or concentric conductors, are being used.

6. Crystals are being widely used for a variety of purposes, such as rectification, detection, frequency control, and frequency conversion.

7. Coaxial cables and hollow wave guides are being used in high frequency circuits to minimize attenuation and interference.

8. New types of directional antenna arrays and devices, such as horns, paraboloidal mirrors, and dummy antennas, are being used to increase efficiency of transmission and to minimize interference.

9. A calibrated short-circuited transmission line consisting of parallel or concentric conductors is being widely used in the measurement of such quantities as wavelength, impedance, dielectric constant, and power.

NEW METHODS

10. Radio broadcasting by means of frequency modulated electromagnetic waves has come into favor because of the possibility of discriminating far more strongly against interfering signals of various origins.

11. Commercial facsimile transmission, both by wire and radio, has become a reality through the development of new types of reproducing apparatus.

12. Telephony has been made much more automatic through wider application of the principle of the relay, particularly in crossbar offices where driving motors, sweeping arms, and sliding brushlike contacts have been eliminated.

13. Progress in television has been made through the development of new types of cathode-ray tubes, large-scale reproduction now being possible both in black and white and in color.

Comparisons may be made between the present and favored treatments of modern developments on the high school level and the present and favored treatments on the college level. To begin with, there is practically no difference between the treatments in high school and college textbooks except that the Giorgi system of units receives much more attention in the college books. Most of the other developments are not mentioned in the texts.

In so far as the present treatment by high school and college teachers is concerned, the same developments are dealt with most frequently by both groups. The Pearson product-moment correlation coefficient for the present treatment (by mention or description) of the thirteen developments by the two groups of teachers was found to be .74. Thus, there seems to be a high degree of correspondence or agreement between those developments with which high school teachers deal and those with which college instructors deal.

On the average, about forty-two per cent of high school teachers mention or describe the modern developments while about fifty-four per cent of the college teachers do so. Thus, the frequency of mention or description of the developments is greater among college instructors by about twelve per cent. This difference was shown to be statistically significant in the sense that there is very little likelihood of finding a group of college teachers by whom the modern developments are treated less frequently than by high school teachers.

In so far as the treatment recommended by high school and college teachers is concerned, the same developments would be desirably treated most frequently by both groups. The Pearson product-moment correlation coefficient for the favored treatment (by mention or description) of the thirteen modern developments for the two groups of teachers was found to be .81. Thus, once again, there seems to be a high degree of correspondence or agreement between those developments which high

school teachers desire to treat and those which college instructors desire to treat.

On the average, about sixty-three per cent of high school teachers recommend mentioning or describing the modern developments while about seventy-five per cent of the college teachers make the same recommendation. Thus, about twelve per cent more college instructors than high school teachers desire to mention or describe the modern developments. This difference is statistically significant in the sense that there is very little likelihood of finding a group of college teachers who, on the average, desire to treat the developments less frequently than high school teachers.

THE CONCLUSIONS

1. A number of changes in the theory or practice of communicating by means of electromagnetic waves have occurred since the year 1932. These developments are concerned with the Giorgi system of units, field theory, wave propagation, new generators, new resonators, crystals, wave guides, directional devices, microwave measurements, frequency modulation, facsimile transmission, automatic telephony, and television.

2. These modern developments are treated to a very slight extent in high school and college textbooks.

3. On the average, about two out of every five high school teachers either mention or describe the modern developments and three out of every five favor their being mentioned or described.

4. On the average, about one out of every two college instructors either mention or describe the modern developments and about three out of every four favor their being mentioned or described.

5. The developments concerned with Giorgi units, crystals, new generators, television, and wave propagation are dealt with most frequently by the two groups of teachers and the same developments would be desirably treated most frequently by the two groups of teachers.

6. Analyses of the modern developments indicate that the electromagnetic waves in use at present have properties very similar or analogous to those of light, sound, or ordinary radio waves and hence many of the ideas or concepts developed in connection with the topics of electricity, light, and sound in elementary physics may be broadened or enriched through a descriptive treatment of recent advances in electrical communication.

REFERENCES

1. Keith Henney. *Principles of Radio,* fourth edition, corrected. New York: John Wiley & Sons., Inc., 1942, p. 362.
2. J. C. Slater. *Microwave Transmission.* New York: McGraw-Hill Book Co., 1942, p. vi.
3. Henney. *Op. cit.,* p. 364.
4. J. F. Bobbitt. *How to Make a Curriculum.* Boston: Houghton Mifflin Co., 1924, pp. 7–9.
5. Educational Policies Commission. *The Purposes of Education in American Democracy.* Washington, D. C.: National Education Association of the United States, 1938, p. 53.
6. Carleton Washburne. *A Living Philosophy of Education.* New York: The John Day Company, 1940, p. 199..
7. J. C. Slater. *Microwave Transmission,* p. 1.
8. Beverly Dudley. Electrical Communication's Part in Modern Warfare. *Technical Education News,* July, 1942.

ABSTRACTS

HAVIGHURST, ROBERT J. "The Community: Education for All Its People." *NEA Journal* 35:140–141. March, 1946.

There are five characteristics of an education suited to the needs of a modern society: (1) Education attempts to make people adaptable to new situations, (2) Education helps people to meet new tasks as they arise, (3) Education is balanced, (4) Education should reach all ages, and (5) Education should reach all social groups.

The content of education should be such as to meet the persistent demands which life makes upon people. Each individual, to lead a successful, satisfying adult life, must master each of a series of developmental tasks as each arises.

VINCENT, WILLIAM S. "Insights Into Emerging Schools." *Teachers College Record* 47:374–381. March, 1946.

The emerging designs of education that are now discernible have to do with curriculum variations, cementing vocational and cultural objectives, widening the range of pupils' experiences, materials of instruction, teaching staff, class organization, and developing the aesthetic possibilities of our population.

CASWELL, HOLLIS. "Scientific Aids to Instruction. *Teachers College Record* 47:354–361. March, 1946.

Types of scientific aids to instruction discussed include: (1) the organization of research facilities in schools, (2) the provision of written and construction materials, (3) the utilization of audiovisual aids, and (4) the provision of standard tests. School buildings, personnel administration, and other phases of school organization and administration should also serve as aids to instruction.

Three general guides appear to be of particular importance in dealing with all scientific aids to instruction: (1) every aid should be selected and used in terms of a general curriculum plan which utilizes all types of materials and activities in relationship to achievement of all the desired educational purposes, (2) every aid should be tested in terms of its actual influence on instruction, all other criteria being recognized as secondary, and (3) aids should be so administered as to facilitate flexible use rather than uniformity of practice.

BRESLICH, E. R. "Some Proposals Regarding the Preparation for Teaching High School Mathematics." *The Mathematics Teacher* 39: 200–205. May, 1946.

Three criticisms of the inadequate teaching of high school mathematics are: (1) pupils do not know how to use their mathematics when they meet problem situations where they need mathematics, (2) pupils dislike mathematics, and (3) teachers make the study unnecessarily difficult, so much that some people believe that a special ability is needed to study high school mathematics. Anyone without mathematical training cannot really be called a cultured and well-educated person. There are so many things he cannot enjoy, appreciate, or understand.

A mathematics teacher must know mathematics, including some of its history. He must master the most effective teaching procedures; he must understand the psychology of the teaching process, and of the learning process of the pupil; he must be acquainted with the history of education; he must be able to use and interpret educational tests and measurements; and he must become a reader of mathematical literature.

RENNER, GEORGE T. "The Globe and the Map." *Teachers College Record* 47:446–458. April, 1946.

This article first discusses the kinds, uses and making of globes and maps in general, then the characteristics, disadvantages, kinds of data, kinds of map projections and uses of specific types of maps. Illustrated.

HENRY, DAVID D. "Opportunities in Science Teaching." *The Phi Delta Kappan* 27:229–230. April, 1946.

Science teachers should be more than imparters of a knowledge of science and an appreciation of the scientific attitude. They need to develop effective methods of teaching scientific method. Students need to learn to use the tools of science effectively. The teaching of modern science should not be done with obsolete machines and equipment.

The social implications and responsibilities of science should be emphasized. Teachers of science have before them a heavy responsibility and a great opportunity.

LICHTON, ELIZABETH S. "Iron and Steel: A High School Unit in World Geography." *The Journal of Geography* 45:188–194. May, 1946.

The explanation of specific iron and steel industry terms and their meanings, a table for the students to fill in, and directions for making a map-story of the iron and steel industry are special features of this unit. A test is given in which the student has an opportunity to apply facts and generalizations which he has learned in the study of the unit on iron and steel.

SEAGEARS, CLAYTON. "The Story of Conservation in New York." *Cornell Rural School Leaflet* 39:1–32. March, 1946.

This leaflet is in reply to a letter requesting information about conservation in New York State. Surely all teachers teaching any phase or having any interest in conservation problems should see this leaflet. It is unique in the type of printing, the literary style, and the pertinent, unique, often humorous, always interesting sketches, and illustrations.

HUTCHINS, ROBERT M. "The Atomic Bomb versus Civilization." *NEA Journal* 35:114–117. March, 1946.

There is only one subject of really fundamental importance at the present moment, and that is the atomic bomb. Although it is not a cheerful subject, we must consider it, for the issue is that of survival, to which all other issues are secondary.—In fifty years we shall probably start a chain reaction that will blow up the globe. —We Americans cannot delude ourselves by thinking we have any scientific or mechanical secrets that can protect us.—There is no defense against the bomb. There is no method of detecting storehouses of bombs or factories which are

making them. Education, international agreements are the only chance.—The task is overwhelming and the chance of success is slight. We must take the chance or die.

SKILLING, WILLIAM T. "Sunshine and the Atomic Bomb." *The Scientific Monthly* 62: 211–218. March, 1946.

The source of energy of the atomic bomb more closely resembles the source of the sun's energy than it does any of man's explosives such as TNT. Energy changes in the bomb and the sun both come from changes deep within the atom. The Bethe carbon cycle change wherein carbon changes to nitrogen to oxygen and back to carbon plus helium ashes is commonly accepted as the source of the sun's heat. In this process 1/140 of the mass of the atom is changed into energy. But in the case of the atomic bomb 1/1000 of the total nuclear energy of the atom is released—energy equivalent to burning nearly 3,000,000 times its weight of coal. Fortunately only a relatively few atoms are involved in atomic bomb energy release. But in the sun 4,620,000 tons of matter are changed into energy each second. Yet at this rate the sun is losing only one per cent of its mass in 150,000,000,000 years.

DAVIS, WATSON; ANONYMOUS. "Background of Atomic Bomb; Atomic Bomb Chemistry." *Science News Letter* 49:394–395; 391. June 22, 1946.

The atomic bomb is the most concentrated blast of energy that man has ever set loose. The explosion lasts less than a millionth of a second and the temperature at the center is estimated at 10,000,000,000 degrees. The articles present some facts relating to the history of the atomic bomb.

ANONYMOUS. "New Elements Named." *Science News Letter* 49:243. April 20, 1946.

Element number ninety-five has been named Americium and element number ninety-six has been named Curium. Co-discoverers are Dr. Glenn T. Seaborg, R. A. James, L. O. Morgan, and A. Ghiorso of the Metallurgical Laboratory of the University of Chicago.

VISHER, STEPHEN S. "Evaporation Regions in the United States." *The Scientific Monthly* 62:453–457. May, 1946.

The rate of evaporation of water is an environmental influence of major importance. A series of eleven maps accompany the discussion material. The author divides the United States into six evaporation regions: (1) Southwest, where evaporation is excessive throughout the year, (2) West, where evaporation is excessive only during warmer half of the year, (3) Plains region, where evaporation is only moderately greater than precipitation, (4) Southeast, where evaporation and precipitation are large throughout the year, (5) East central, where evaporation exceeds precipitation in warm half of year and (6) Pacific Northwest, and Northeast, where precipitation exceeds evaporation except for a few weeks in summer.

ABBOT, C. G. "The Sun Makes the Weather." *The Scientific Monthly* 62:201–210, 341–348. March and April, 1946.

This illustrated article describes the investigations in studying the sun—instruments, observations, interpretations and conclusions. Instruments have been developed so sensitive as to measure the sun's heat to 0.000,001 degree. There is definite variation in the sun's heat, seemingly a whole series (as many as 15 solar periods have been observed) of cycles including a short period of three or four days and a long period of twenty-two and three-fourth years. It seems that the old eleven year weather cycle is really a half-cycle (as determined from changes in polarity of the sun's magnetic field). However, this eleven and one-third year sun-spot cycle does produce corresponding changes in temperature and rainfall.

Ionization studies seem to offer much hope for weather forecasting. Dr. Abbot believes ten day forecasts of present accuracy are soon to be hoped for, and even general yearly forecasts are a definite possibility.

ANONYMOUS. "Measurement Standard." *Science News Letter* 49:242. April 20, 1946.

The transmutation of gold into mercury 198 in the cyclotron has produced a standard which is ten times as accurate as the one now accepted. Measurements can be made with an accuracy of billionths of an inch. The cadmium standard of length was adopted in 1893 as the primary standard of length and it had not been improved upon until the new mercury standard was found.

ANONYMOUS. "Drowned Archipelago." *Science News Letter* 49:358. June 8, 1946.

Echo-sounding apparatus has disclosed 160 submerged flat-topped mountains located between Hawaii and the Marianas. Some evidence lends support to the idea that they are volcanoes that were once above the sea and may date back to Pre-Cambrian time—more than half a billion years ago.

MORROW, MARTHA. "Our Perfumed World." *Science News Letter* 49:298–299. May 11, 1946.

Inexpensive synthetic odors makes possible the wide use of perfume. The fragrance of a few flowers never captured in nature has been duplicated. Soap, toothpaste, shaving cream, lipstick, hair tonic, face powders, and even fabrics, synthetic rubber and medicine are among large users of perfumes. Sources of perfumes and methods of obtaining both the natural and synthetic product are explained.

Anonymous. "New TB Treatment." *Science News Letter* 49:325. May 25, 1946.

A new kind of iron lung in which advanced tuberculosis patients actually stop breathing for eight to eleven hours at a time has proved quite effective. The treatment lasts from four to twelve months. Air is merely wafted in and out of the lungs, leaving the lungs completely at rest.

Cowdry, E. V. "Hopes and Hurdles in the Cancer Problem." *The Scientific Monthly* 62: 301–309. April, 1946.

The cancer outlook is definitely much more encouraging. The cancer problem is being explored along many trails, many of which are quite hopeful. Cancer in man dates from prehistoric times. Cancer unlike many other diseases is not limited to any age group. Deaths from cancer in children under five years is greater than for infantile paralysis or from all diseases of ear and mastoid lumped together. However, the greatest number of deaths from cancer in men is from 60–69 and in women from 50–59. Cancer can develop in more parts of the body than most other diseases. Cancer is also set apart from other diseases in the far greater number of agents that can produce it. The feature of cancer most difficult of analysis is susceptibility. There seems to be a great variation in the time necessary to produce cancer—some provoking agents taking many years.

BOOK REVIEWS

Masters, Dexter, and Way, Katherine (Editors). *One World or None*, New York: Whittlesey House, McGraw Hill Book Company, 1946. 79 p. $1.00.

A more appropriate title, *One World or None* could hardly be imagined, for this symposium on the implications of the atomic bomb whether political, economic, military, social, or even biological. We have now begun Atomic Age, Year 2, for surely the atomic bomb confronts man with the most challenging problem that he has ever been called upon to face—the solution of which may well determine his very existence. Has man the intelligence and the good will to meet this challenge? Our survival is at stake and the time is short.

Contributors to this symposium are among the foremost scientists of America and of the world. America and the world can well afford to take most seriously their pronouncements and to heed their advice. Every American as well as every citizen in the world should read and understand the gist of what they have to say. No place else has it been said by so many and so well.

Contributors to the symposium are as follows: *Introduction* by Arthur H. Compton; *Forward: Science and Civilization* by Niels Bohr; *If the Bomb Gets Out of Hand* by Philip Morrison; *It's an Old Story with the Stars* by Harlow Shapley; *Roots of the Atomic Age* by Eugene P. Wigner; *The New Power* by Gale Young; *The New Weapon: The Turn of the Screw* by J. R. Oppenheimer; *Air Force in the Atomic Age* by H. H. Arnold; *There Is No Defense* by Louis N. Ridenour; *The New Technique of Private War* by E. U. Condon; *How Close Is the Danger?* by Frederick Seitz and Hans Bethe; *An Atomic Arms Race and Its Alternative* by Irving Langmuir; *How Does It All Add Up* by Harold Urey; *Can We Prevent an Arms Race by an Inspection System* by Leo Szilard; *International Control of Atomic Energy* by Walter Lippman; *The Way Out* by Albert Einstein; and *Survival Is at Stake* by Federation of American (Atomic) Scientists.

—C. L. D.

Brodie, Bernard (Editor). *The Absolute Weapon: Atomic Power and World Order*, New York: Harcourt, Brace and Company, 1946. 214 p. $2.00.

The first atomic bomb was a victory of the most startling and conclusive sort for scientific research. But having achieved this miracle, the scientists themselves are not certain that mankind has been the gainer by this research.

Discussed in turn are the three major fields in which the atomic bomb has wrought profound changes: (1) in the military affairs of nations, (2) in their political relationships, and (3) in the organized international machinery for peace and security.

War in the atomic age advances the following major theses: (1) The power of the present bomb is such that any city in the world can be effectively destroyed by one to ten bombs, (2) No adequate defense against the bomb exists, and the possibilities of its existence in the future are exceedingly remote, (3) The atomic bomb not only places an extraordinary military premium upon the development of new types of carriers but also greatly extends the destructive range of existing carriers, (4) Superiority in air forces, though a more effective safeguard than superiority in naval or land forces, nevertheless fails to guarantee security, (5) Superiority in number of bombs is not in itself a guarantee of strategic superiority in atomic bomb warfare, (6) The new potentialities which the atomic bomb gives to sabotage must not be overrated, (7) In relation to the destructive powers of the bomb, world resources in raw materials for its production must be considered abundant, and (8) Regardless of American decisions concerning retention of its present secrets, other powers besides Britain and Canada will possess the ability to produce

bombs in quantity within a period of five to ten years hence.

Professor Oppenheimer says, "The pattern of the use of atomic weapons was set at Hiroshima. They are weapons of aggression, of surprise, and of terror. If they are ever used again, it may well be by the thousands, or perhaps by the tens of thousands."

The atomic bomb will be introduced into a conflict only on a gigantic scale. No belligerant would be stupid enough, in opening itself to reprisals in kind, to use only a few bombs. The ability to fight back after an atomic bomb attack will depend on the degree to which the armed forces have made themselves independent of the urban communities and their industries for supply and support.

Part III discusses the atomic bomb in Soviet-American relations. The last two parts discuss effect on international organization and the international control of atomic weapons. Possibilities and pitfalls of all of the methods of control that have been suggested from individual treaties between states to international control bodies are examined. *The Absolute Weapon* provides no panaceas; it shows the dangers of both the "tell-all" and "do-nothing" schools in respect to America's present monopoly on the atomic bomb. Certainly the atomic bomb is the greatest challenge in man's history. Wise statesmanship and rational planning can solve the problem. Immediate world government or chaos are not the only alternatives as we grope about in finding freedom from fear of the absolute weapon.

—C. M. P.

MACKENZIE, DEWITT. *Men Without Guns.* Philadelphia: The Blakiston Company, 1945. 145 p. $5.00.

This is an unusual book which is of large page size (10" x 13") including 47 pages of textual material; reproductions of 137 plates from the Abbott Collection of Paintings owned by the United States Government and made by twelve distinguished artists who "braved the hardships and perils of war to make the notable series of historical paintings"; foreword by Major General Norman T. Kirk, Surgeon General; and descriptive captions for each of the 137 plates by Major General Clarence Worden.

The text introduces the Army Medical Department and gives the reader a general picture of its work in the war. Each of the 12 artists is given a brief biographical sketch. In, "Doctor to the Army," how the medical corps operates on the battlefield and in hospitals at a distance, is told in story-like form, and some conception of preparations made in England and on the Western Front is given. Medical supplies, hospital ships, hospitals and personnel—regulars and specialists, nurses, and enlisted helpers—are pictured. The work of the nurse is particularly stressed. A brief account of the training schools for medical personnel is also given.

Similar sections describe the work in the "Southwest Pacific," "Saipan." "Italy," "D-Day in Normandy," and the "Burma Road." The last one, "The Warrior Comes Home," shows how the wounded in body and mind are "followed up," when they return to the homeland—the reconditioning necessities. The descriptions and explanations are all told in the "easy-to-read" style of the experienced journalist. Much of the text presents true-to-fact incidents and stories.

The illustrations are particularly outstanding—jungle, the night rendezvous and vigil, tanks, planes, Red Cross workers, return, cargo, laboratory warfare, Sunday religious scenes, evacuation under fire, death, and rehabilitation—all with reference to the men and women who "save lives"—are shown in beautifully colored large and small reproductions. They have received commendations from many nationally prominent men and women.

Everyone should see and read this unique book.

—A. W. H.

SUMNER, FRANCIS B. *The Life History of An American Naturalist.* Lancaster: The Jaques Cattell Press, 1945. 298 p. $3.00.

Autobiography and biography have much in common, or should have, but are very different. The first is usually the author as he appears to himself and the second as he appears to others. The two pictures would rarely be the same.

In Dr. Sumner's story he begins with his own beginning recounted from hearsay. He accounts for alleged quirks in his personality by describing his early strained relations with parents, others of his family, and those of his environment. His elected loneliness as a youngster, his nature wanderings and collections are somewhat like those of many other naturalists. Even before he was ten years old he seems to have become a competent and almost self-sufficient field observer. Having been taught by his father and attending no regular school until after his first ten years, tramping and living alone a good deal, might be factors in some of the characteristics the author accredits to his heredity. Of his college education which he began at sixteen, he says his formal education "was highly successful," while "socially it was an almost complete failure." As one reads the book he may justly conclude that the preceding quotations almost tell the full story. He was a decidedly competent scholar, but decidedly aloof from many engaging and useful human contacts.

Sumner was a graduate student at Columbia University, a teacher at City College, a student in the Cold Spring Harbor laboratory, a devoted Woods Hole student, a student in the Naples Zoological Laboratories, and was associated as student or fellow teacher with such great biologists as E. B. Wilson, Henry Fairfield Osbourn, J. H. McGregor, Bashford Dean, C. J. Herrick, and James McKeen Cattell. He became director

of the Woods Hole Bureau of Fisheries, now the U. S. Fish and Wild Life Service. While here his personal studies related to inheritance in white mice and to the Biological Survey of the Woods Hole region. Then came a two-year assignment on the biological survey of San Francisco Bay as a joint project of the University of California and the U. S. Bureau of Fisheries, this leading to his last long-lap position as research specialist in the Scripps Institution for Biological Research at LaJolla, California. That Institution is now known as the Scripps Institution of Oceanography. From this time on, Sumner's work related mostly to the geographic distribution and hereditary qualities of the common brown mouse about which he probably knows more than all other scientists.

—OTIS W. CALDWELL

COLLINS, A. FREDERICK. *Science for Young Men.* New York: D. Appleton Century Company, 1946. 257 p. $3.00.

This new book of Frederick Collins with its unusual title is intended for all boys and young men interested in entering any branch of the aviation industry but who have had no training in the air service. The book comprises the basic principles of science taught in high schools, colleges, trade and scientific schools, the Army, the Navy, and the Marine Corps such as surveys, air maps, photography, electricity, radio, meteorology, gliders, construction and operation of airplanes. If the reader is interested in a ground job as an airplane mechanic, there is the valuable chapter, "A Ground Course in Aviation." There are eight chapters packed into these two hundred odd pages, profusely illustrated with one hundred forty-six graphic and helpful diagrams and drawings. —G. O.

CABLE, E. J., GETCHELL, R. W., AND KADESCH, W. H. *Science in a Changing World.* New York: Prentice-Hall, Inc., 1946. 622 p. $5.00.

Here in one easy-to-read, fascinating volume are all the basic facts that the general reader should know about the physical sciences today. Chemistry, geology, physics, climatology, astronomy, man and his machines, electricity, etc., are described in practical terms to give the general reader a good grounding in science. This is the sixth edition and is completely revised and brought up to date with the questions of the atomic age. It is a science book but it reads like fiction. —G. O.

LOW, A. M. *Tick-Tock, a Journey Into the Wonderland of Science.* New York: Robert M. McBride and Company, 1946. 259 p. $2.00.

Tick-Tock is a new kind of book about science. Professor Low is a well-known scientist and has the remarkable gift of presenting scientific facts with charm. It is the picturesqueness here that will charm the youthful reader between the ages of nine and twelve and many an oldster. In *Tick-Tock* the reader is taken around the clock through the four seasons of the year to learn the things that Nature's creatures do during these seasons of their existence. The book begins with an explanation of the mystery of time after which the drama of Nature unfolds itself with the arrival of spring and the coming of winter and the seasons in between. The drawings of Amy Low are unique and original and must be seen to be enjoyed. Boys and girls will enjoy the adventures here with Bill and his sister, Twinks, and Mr. Tempus Pobblethwaite.

—G. O.

RUDOLPH, J. A., AND ROSE, HOWARD N. *What You Don't Know May Hurt You!* Philadelphia: Dorrance and Company, 1946. 138 p. $1.50.

Here is a book on allergies. You'll be amazed at the number and type of allergens that react against the human body. You may even have some of the symptoms. All cases related or referred to are authentic and mostly drawn from the authors' own files. The popular style in which the book is written and the pictures that illustrate the incidents will give the reader a laugh and much valuable information about himself and this most predominant medical disorder.

—G. O.

CLINE, JOSEPH L. *When the Heavens Frowned.* Dallas, Texas: Mathis, Van Nort & Company, 1946. 221 p. $3.00.

This is the autobiography of a much beloved Texas weather man, an early Texas meteorologist who worked hand in hand with the U. S. Weather Bureau in its infancy. He was the first to advocate winter gardening in Texas and did much to develop it and protect it by his accurate weather forecasting. His graphic story of the Galveston hurricane of 1900 is a gripping one. After the Galveston storm, he was stationed in Porto Rico and later in Indiana. His intimate study of Texas weather and Texas horticulture while in Corpus Christi, Texas, resulted in his recognition as an authority on climate in the Southwest. Dr. Cline was transferred to Dallas in 1913. His painstaking weather forecasting and delightful personality make him still popular as a forecaster and lecturer. His reminiscence, letters, and papers make this book not only a good autobiography but a good history of weather forecasting.

—G. O.

HORNING, JOHN L., AND MCGINNIS, GEORGE C. *An Open Door to Chemistry.* New York: D. Appleton Century Company, 1946. 86 p. $2.00.

These two California school principals came together to write a book because both of them thought that most boys and girls did not realize that science could be just as much a home hobby as any other hobby and just as much fun. The

experiments are safe to perform at home and can be performed with the simplest equipment, mostly things that can be found in a drugstore. The step by step cartoons which show the how and the why make the experiments easy to perform. Neither the technique nor the science of experimenting are forgotten in this cleverly written book which offers boys and girls good chemistry and good fun.

—G. O.

DUBKIN, LEONARD. *The Murmur of Wings.* New York: Whittlesey House, McGraw-Hill Book Company, 1944. 167 p. $2.50.

The author's stated goal, "to write a book about my experiences with birds in the midst of a great city," (Chicago) is achieved, to the delight of the reader. As an autobiography of the outdoor interest of a journalist, this volume is rich in humor and dotted with original figures of speech.

Although in a world gone mad, Dubkin recommends attention to birds as "a part of the reality of present-day life," since birds are such sane and logical creatures, he stoutly maintains till the last sentence that he is not among the so-called "bird lovers." Of them he states that they are "a greater menace to bird life than boys with air rifles or men who hunt ducks and quails and pheasants."

In support of this conclusion he offers the likelihood that many birds which learn to depend on feeding stations probably perish when a blizzard makes the window hard to open. He pokes fun at "bird lovers" for being "so anxious to make converts that they paint glorified pictures of their 'feathered friends,' endowing them with human intelligence and superhuman appreciation of little kindnesses." He then quotes some of the letters to the "readers" department in his newspaper. One tells of two sparrows supporting a sick sparrow between them. Another set off a flood of letters and headlines by describing a hawk capturing a pigeon on the grass beside the Art Institute.

This book would be of no use to persons who see science teaching as only the recital of facts. Many others would enjoy it. It is especially recommended to Boy Scouts working for the merit badge on Bird Study.

If thwarting the ambition of a twelve-year-old would-be naturalist, who kept copious notes about birds, results eventually in a book as interesting as this—may we have more of them!

—M. E. O.

NICHOLS, JOHN T., AND BARTSCH, PAUL. *Fishes and Shells of the Pacific World.* New York: The Macmillan Company, 1945. 201 p. $2.50.

CURRAN, C. H. *Insects of the Pacific World.* New York: The Macmillan Company, 1945. 317 p. $3.75.

These volumes are in "The Pacific World Series," prepared under the auspices of The American Committee for International Wild Life Protection. Others are on Plant Life, Reptiles, Mammals, Native People, and a general volume —*The Pacific World.* One wonders why birds are omitted.

The first one above is really two volumes in one—Fishes and Shells.

The author of "Fishes" has served on the staff of the American Museum of Natural History, Department of Ichthyology, since 1909, being Curator of Recent Fishes since 1928.

After general chapters on Origin and Distribution of Pacific Fishes, Different Kinds of Fishes, and Collecting Specimens, which are for general reading, there are reference chapters on Sharks and Rays, Important Fish Groups, Peculiar Fishes, and Game-Fishes. Fresh-water and deep-sea fishes are not included. Odd fishes, such as the Australian sea-horse, the pilot-fish, the mud skipper, and the small fish which stays near the jelly-fish known as the Portuguese-man-of-war, vie for interest with the colorful coral-reef fishes.

The author of the section on Shells is on the staff of the Smithsonian Institution, Division of Mollusks, since 1896, Professor Emeritus of Zoology at George Washington University, and member of many field expeditions.

In this section there is a general chapter on the fossil record, distribution, and classification of mollusks, a chapter on the mollusks likely to be seen by the general observer in the West Pacific, arranged systematically, and a final chapter on collecting and preserving mollusks. The plates of illustrations are excellent. It might be difficult for a novice to find the names of the ones shown on the text-page lists. There is a bibliography for one who wishes to make further study of shells.

The author of the volume on Insects is Associate Curator in the Department of Entomology, The American Museum of Natural History since 1928.

Following a Foreword by Fairfield Osborn, President, New York Zoological Society, and a general chapter on Insects and their Relatives, there are ten chapters on the main orders of insects, then one on Spiders and other Arachnids, and finally, chapters on Insects and Disease, and on Collecting, Preserving, and Shipping Insects. Common names, excellent drawings, and chatty style make this a usable handbook on this, the most numerous group of organisms.

These volumes have good index and appeal to those Americans who are, as never before, scattered over the world. The shores of the Pacific include so considerable an area of the world's surface that those Americans stationed around that ocean find many strange forms of life. Some of them are fishermen, some are naturalists, and many are interested in anything strange, uncommon, or new to them.

Here are the books to help them satisfy newfound curiosity. —M. E. O.

ROSEN, GEORGE (Editor). *Journal of the History of Medicine and Allied Sciences,* Volume I, Number 1, January, 1946. 183 p. $7.50 per year. (Issued Quarterly).

This is a new journal and one of only two in the United States which treats of the history of medicine. It has been planned to stress history of the development of medicine in general—not the technical aspects. The contents of this first number may give a general conception of the type of material which is solicited from competent writers. There are eleven major articles: (1) "What Is Past Is Prologue"; (2) "Some Galenic and Animal Sources of Vesalius"; (3) "The ' ndon Years of Benjamin Waterhouse"; (4) "A Note on William Blake and John Hunter"; (5) "Pharmacopeias as Witnesses of World History"; (6) "The Two Earliest Dentistry Woodcuts"; (7) "Bernardino Montana De Monserrate"; "Dr. Benjamin Harrison, Temporary Texan"; (9) "Medical Education in the 17th Century England"; (10) "Incubator and Taboo"; (11) "Animal Substances in Materia Medica".

In addition are sections on "Notes and Queries"; "Book Reviews"; and "Notes on Contributors."

There is a Board of five editors, and 43 consulting editors representing most areas in the United States, and many Central and South American, and European countries. Apparently, the intention is to make it world-wide in scope.

This first number is really a paper-covered book, 6¾" x 10" in size, printed on heavy paper, and substantially bound so as to last a long time. It is published by Henry Schuman, 20 East 70th Street, New York 21, New York.

The editors solicit historical articles of the type mentioned, from the fields of "medicine, public health, dentistry, nursing, pharmacy, veterinary medicine, and the various sciences that impinge on medicine." The first article—"What Is Past, Is Prologue"—discusses the purposes underlying the motivations of the publishers in launching this new publication. —A. W. H.

REID, MARSHALL. *When You Build.* New York: Robert M. McBride and Company, 1946. 160 p. $4.00.

Anyone contemplating building a home will find themselves well repaid both financially and in happiness for having read and thoughtfully examined this book. Leading architects and writers on architectural subjects have contributed the articles and the almost 400 illustrations and plans that make up such an integral part of this artistically appealing book. Homes for every clime, every size and every purse are included with photographs, floor plans and interesting commentary.

George Nelson, a well known architect and writer, discusses at some length the site, learning to read blueprints, windows and doors, the walls, floors, roofs, heating, bathrooms, interior finishes, lighting, equipment, flexible living space, landscaping, and fences.

Americans will build many millions of homes when once the strikes and lack of materials bottle neck is removed. Books like this should be carefully considered by those building a home that will possess the maximum of comfort, is practical, that has aesthetic appeal, and will cost the minimum. —G. E. D.

WILLIAMS, PAUL R. *New Homes for Today.* Hollywood: Murray and Gee, Inc., 1946. 95 p. $2.00.

This paper-covered book about new-type homes will appeal to those who live in climates and settings where the ranch house is appropriate or perhaps to those who like to own a country, lakeside, or seashore home. In recent years the ranch type of home has become very popular. "The Veteran," "The New Suburban," and "The Year Around Home" are types of homes that seem practical if a basement is not needed. Heating, ventilating and the possibility of being able to sell the house are all factors one needs to consider. However, if the house is to be used only part of the year or on week-ends the essential requisites of the house are different.

An excellent plan, "Hillside Estate" is given for a two-story home. The "Garden retreat," "The Leisure room," "The playroom," and "The Living-dining room" are all designs and suggestions the modern home-builder will want to examine. The homes featured in this book are definitely suited to California and the southwest where gas is used for heating purposes, where it is dry, and where the wind blows almost constantly. Floor plans as well as illustrations of each house are given and suggestions for construction. Plans of most houses can be secured from the publisher at nominal cost.

—F. M. D.

CATLIN, MARY AND GEORGE. *Building Your New House.* New York: Current Books, Inc., A. A. Wyn, Publisher, 67 West 44th St., 1946. 267 p. $2.75.

If you are interested in building a home in the $3,000 to $10,000 range this is a book you should read. George and Mary Catlin decided upon George's entering college at Ames, Iowa, to build a home of their own. The Campus house, which George built for the most part himself is carefully described as to plans, details, financing, etc. In all, the Catlins have built eight houses. Since they were only recently built, their ideas for building are most practical and up-to-date.

Some facts they learned from experience and pass on to others are: They found that the first house they built, campus cottage, was too small—should have been built larger so that furniture might not have to be stationary, but room sufficient to move and arrange it elsewhere. They decided that a basement and furnace would have

been worth the extra money. It doesn't pay in satisfaction to pass up conveniences which simplify everyday living. In colder climate, it is better to place the front door under shelter and plan to use storm doors and windows. Mrs. Catlin, a writer, found it best to live in an exclusive district. It is something to have a good address. After they had built the house, they could sell it easier and for a higher price than if it had been in a less desirable district. She tells why the cost of the detached and attached garages are about the same. An extra room over the garage was a good selling point. A straight drive and on-level-of-floor of garage is best. From the book one can learn how to treat and finish knotty pine walls.

"Intangible satisfactions come from home ownership. You're just naturally more interested in a house that belongs to you. You have space for hobbies. You plant trees and shrubs and watch them grow. You belong to the community." In buying a house, living in it before it is definitely decided upon will be to one's advantage. The measurements and many facts as to color decorations must be well-planned on your part or it may be done differently and prove unsatisfactory.

Some specific advice given is that if you really wish to save money, do not put in two bathrooms. If more than four rooms, then a two-story house may be the best solution. Plumbing is the highest priced thing you put in your house. Plumbing and heating may amount to 20 per cent of the total cost of the house. How to select the lot and plan and build a good house economically is carefully told by Mary and George Catlin. —F. M. D.

FARNHAM, R. B., AND INGHAM, VAN WIE. *Grounds for Living: The Home-dwellers Complete Guide to His Lawns, Trees, and Garden.* New Brunswick: Rutgers University Press, 1946. 334 p. $2.50.

"Home is everything on a man's own property that makes for happiness." This book was no doubt written in anticipation of the close of the war when all of us realized many people who had never had the joy of owning their own home would want to build one, furnish it, and develop the grounds about it to their own liking.

If you are going to grow roses, chrysanthemums and gladioli to your satisfaction, then this book will help you. Then, too, you don't want one single failure in your vegetable garden and if you read *Grounds for Living* and take the advice given about the soil, you won't likely have one. Just a small lot isn't large enough, for you need an acreage large enough for fruit trees, vines, and berries, beautiful spreading elms and maple shade trees, shrubs and flowers. "Plan it all, then try to achieve your artistic longings" is the advice of the authors.

In the care of the lawn we might make a resolution, "I promise to mow my lawn no closer than one and one-half inches from now on." This is a system of management that is fair to the grass and to you too, and a system that makes your job of maintaining the lawn many times easier.

Some ten specialists have contributed to the writing of this book—specialists in the field of agriculture, soils, horticulture, and plant pathology. Many illustrations, pictures, tables, and sources of additional information add to the value and usefulness of the book. Aesthetically as well as economically, it pays to own a home. —F. M. D.

BAKER, RACHEL. *Dr. Morton: Pioneer in the Use of Ether.* New York: Julian Messner, Inc., 1946. 224 p. $2.50.

When the reviewer finished reading Rachel Baker's *The First Woman Doctor* (the biography of Elizabeth Blackwell) she doubted if the author could ever equal that remarkable biography. Surely that is one of the best written biographies yet published. This is equally good. Both are recommended as excellent for the science library, the science teacher, and any high school boy or girl.

Along with Pasteur, Jenner, and Harvey, Dr. Williams Thomas Green Morton is surely one of the greatest benefactors of mankind. But the discoveror of ether that put an end to the hacksaw era in surgery and the agony of the operating room was not so recognized or honored in his day. As other claimants, (notably Dr. Charles Thomas Jackson, a chemist and Dr. Horace Wells) rose to question his claims, he was refused the honors and awards that were so rightfully his. He was insulted, robbed of his profits, hung in effigy in his home town. Many years of struggle against the scurrilous attacks made upon him left him penniless and broken in health. A sensitive soul, he suffered bitterly from these cruel and unjust attacks and finally died in Central Park in New York City from an attack of apoplexy brought on by his fight against his enemies. He was never to know that one day he would be proven right, elected to the Hall of Fame, and be acclaimed as one of the greatest contributors to medical advancement.

The loyalty and love of his wife, Elizabeth Whitman, shines like a beacon light through all the long and bitter years as first he struggled to discover a pain killer, later to perfect the use of ether as an anesthetic, and the final bitter, dreary years of trying to prove he was the first to use ether as an anesthetic. —G. B. K.

O'NEILL, JOHN J. *You and the Universe.* New York: Ives Washburn, Inc., 1946. 328 p. $3.50.

The material comprising *You and the Universe* was written for and published originally in the New York *Herald Tribune*. The author is a well known science writer, Science Editor of the *Herald Tribune* since 1932, a Pulitzer Prize Winner, and the author of *Prodigal Genius: the Life of Nikola Tesla.*

You and the Universe is a Scientific Book Club selection. A reading of this book confirms that it is one of the best choices that could have been made. Probably some of the recent books on atomic energy and the atomic bomb have more deservedly caught the popular fancy, but were it not for the tremendous significance of atomic energy, this book would surely take its place near the top, if not at the top, of all popular books that have been written in the last decade.

It is packed so full of information, answers so many questions as to what science is doing and has found out, and in a most readable literary style, it should remain an outstanding favorite for some years to come.

A summarization of the book is really impossible, and every part seems so important and interesting when you read it. It is all so effectively said. Part I emphasizes man: Lords of Creation (Anthropology); The Old Adam (Archaeology); The Lesser Fauna (Zoology); Science of Life (Biology); The Universe Within (Physiology); The Will to Live (Medicine); and Mind Over Mind (Psychology). Book II emphasizes the Universe: World Almanac (Climate); The Earth Below (Geology); The Sum of Things (Mathematics); Mind Over Matter (Physics); What Is It! (Physics); Alloys, Heat Energy (Engineering and Chemistry); and The Heavens Proclaim (Astronomy).

Death from old age is an extremely rare event. Were it not for specific "accidents", many, if not most, people could live over a hundred years. The season of conception seems to influence the persons later life to a very considerable degree. Sumerian Tablets being translated at the University of Pennsylvania bridge a span of 7,000 years of human history.

The world is well supplied with living fossils: the 50,000,000 year old Crossopterygian fish of the Mesozoic caught not so long ago off the coast of East Africa; the Amphioxus dates back more than 400,000,000 years.

Science affirms that animals do talk and think. They have to, in order to survive. The ten most intelligent animals in order: 1, chimpanzee; 2, orang-utan; 3, elephant; 4, gorilla; 5, domestic dog; 6, beaver; 7, domestic horse; 8, sea lion; 9, bear; 10, domestic cat.

One of the most strongly intrenched dictatorships in the science of biology appears to be on the way out. This dictatorship has been credited to our genes and chromosomes—the carriers of our inheritance—in making us what we are. Soon heredity will be forced to share its rule with environment.

Time does pass more rapidly in age than in youth. A child grows old very rapidly and in the half-dozen years from ten to sixteen a boy does as much ageing as he will do in the years from 35 to 80. Time flows four times as fast for a man of 50 as for a child of 10.

The climate of the world seems to be getting warmer, and also more dry—at least in New York City.

The magnetism of the earth is decreasing at about the rate of one part in 1,500 years. There also seems to be indications of a change in the magnetic polarity of the earth, and a shift of the north pole to a region west of equatorial Africa.

Earthquakes may be set-off by the moon—the extra moon-pull being just sufficient to release the strain previously set up.

Absolute zero has been approached to within .001 degrees through magnetization of helium. Metals have very different properties when subjected to very low temperatures or very great pressures. The scientists have not yet decided exactly what electricity is. They only know that it does certain things and has certain characteristics when certain things are done.

The sun is rotating about our galaxy once in 250,000,000 years, moving at a speed estimated to be about 400 miles a second. Our galaxy is about 100,000 light years in diameter and consists of between one and two hundred billion stars. The sun is nine-tenths of the way from the center. The sun is not over 10,000,000,000 years old, which is about 4 or 5 times the age of the earth. There is a red giant star, V V Cephei group, which has a diameter of 186,000,000,000 miles. It is now believed that more than 60 per cent of all stars have visible or invisible companions. —C. M. P.

COLBERT, EDWARD H. *The Dinosaur Book.* New York: The American Museum of Natural History, 1945. 156 p. $2.50.

There were giants in those days—the giants being dinosaurs and the days Mesozoic. The term dinosaur has become a rather common term—a word that stands for strength, size, and antiquity. The most complete collection of dinosaur fossils is that of the American Museum of Natural History where the author is Curator of Fossil Reptiles, Amphibians, and Fishes. A fossil is the remains or the indication of past life upon the earth. It may be either a skin, body outline, bony armor, bone, egg, footprint, imprint, mold, and so on.

The dinosaurs lived during the Mesozoic beginning about 200,000,000 years ago. They persisted through a period of some 140,000,000 years and disappeared about 60,000,000 years ago. They were reptilian in character, their immediate ancestors being reptiles. They were of all kinds and sizes—from the largest animals to ever walk on the surface of the earth, to many that were very small. Some were carnivorous and very fierce, and others were herbivorous. Some walked on two legs, the two front ones being used mainly for holding prey, some were flying reptiles, and many lived in the sea. Many were covered with heavy, protective armor. Tyrannosaurus had powerful hind legs, carried his head some 20 feet above the ground, and was 50 feet in length. Brontosaurus which lived in North American marshes some 125,000,000 years ago was some 80 feet long and weighed

40 tons. It had a rather small head and lived upon plants. The flying reptiles were often no larger than robins, although one had a wing-spread of 27 feet.

Many of the dinosaurs were strange in appearance—those in armor, some with collars and frills, others with duckbills, and so on. Strange adaptations to the environment were made by the dinosaurs. Many of the lowland dinosaurs were probably slow and sluggish. They reproduced by means of eggs and indeed there was great satisfaction when dinosaur eggs were found several years ago in Mongolia, concrete evidence of a theory long held.

Reasons for the decline of the dinosaurs are probably many. Racial senescence accompanied by overspecialization may have been a factor. Destruction of their eggs, epidemics, upsets in glandular secretions, general sluggishness may have been partial causes. At any rate great climatic changes with much mountain building brought the period to a close and the modern crocodiles became their only survivors.

The story of the dinosaurs is told remarkably well. It is a most interesting book for any layman or science teacher interested in knowing more about the dinosaurs. Many splendid photographs, diagrams, and charts supplement the general discussion. It is the most complete book on dinosaurs that has been published and will be in great demand. —R. J. A.

HYLANDER, C. J., AND HARDING, R., JR. *An Introduction to Television.* New York: The Macmillan Company, 1946. 207 p. $2.50.

The historical method of approach has been used in this book. It traces step by step the pertinent scientific developments that have led to the development of television. While television has made remarkable development, it is still a science in progress and many kinks remain to be eliminated. Before 1950 many homes may have television sets. Probably two to four decades will elapse before it is common as radio is today. However, the telecasting of the opening of the New York World's Fair in 1939 passed television beyond the experimental stage. It marked a milestone in a comparatively rapid sequence of events. Only sixteen years previously (1923) a Scotch inventor projected televised shadows on a screen.

In turn the authors discuss the nature of television, the birth of television (scanning by disks, mirrors, electrically), the radio tube (as amplifier, generator, modulator and detector), the ether highway, the television camera, putting the picture on the air, and the television receiver. The last chapter discusses transmission in the future, future receivers, television in color, and the uses of television in education and entertainment.

Altogether this account is one of the most understandable descriptions of television that has yet been written. Mr. Harding is former president of the National Television Company. Dr. Hylander is a science writer of note. His *The World of Plant Life, Out of Doors in Spring, Out of Doors in Summer, Out of Doors in Autumn* and *Out of Doors in Winter* are especially well known. He is a former Professor of Botany at Colgate University. Other of his books include *American Inventors, American Scientists, Cruisers of the Air,* and *The Boy's Own Book of Great Inventions* (with Darrow). —C. M. P.

HYLANDER, C. J. *Flying Power.* New York: The Macmillan Company, 1943. 164 p. $2.00.

This is a technical book, for boys and laymen, on aircraft engines and their operation. The author seems to have done an unusually good job on making the really complicated airplane engines readily understandable. In a way, he really takes the engine apart and puts it together again.

Principles of internal combustion, parts of an aircraft engine, how fuel gets to the induction system, how the induction system prepares the fuel for combustion, how the fuel is ignited, how the engine is lubricated, aircraft propellers, and engine instruments are among the many things explained. There are 53 pertinent diagrams by the author. The usefulness of the book in teaching practical and theoretical aspects of the subject so that a beginner can really grasp it quickly and understandably is attested by the fact that the author taught engine operations to hundreds of cadets.

Science classes, classes in high school aviation, and auto mechanics will find this one of the best and most understandable books published on engines and their operation.

—C. M. P.

MILLER, THOMAS H., AND BRUMMITT, WYATT. *This is Photography.* Garden City, New York: Garden City Publishing Company, 1946. 260 p. $2.00.

This Is Photography is intended for anyone who has ever made pictures. Because of its cheerful and interesting style, the book is both instructive and pleasant reading. This is one of the most attractive books on photography the reviewer has seen. The quality of paper is unusually good and many fine illustrations are pertinent to the descriptive material. Photographs showing good and poor techniques and other errors, used side by side, are especially commendable.

The authors are expert practical photographers. Many practical experiments are suggested and because of its organization and comprehensiveness the book is suitable for use in photography classes or by individuals. Any one using a camera can find material of practical use and interest.

Not an encyclopedia of photography, yet a surprisingly large number of fundamental topics are

discussed. Contents include: You and your camera; Which camera?; Lenses; Be camera-wise; Films; Developing films; Photographic paper and printing; Enlarging; Filters; Color photography; Shooting in color; Pictures, free style; Land, sea and sky; Action; By flood and flash; Pictures of people; There are tricks in all trades; Special purpose photography; and Now that they're finished. —C. L. D.

Banks, A. J. *Checker Board Strategy Made Easy.* Philadelphia: David McKay Company, 1946. 159 p. $2.00.

Unlike card games, checkers and chess never depend upon the draw. Checkers have always been popular and the game lends itself so as to involve either a minimum of mental effort or to as challenging a game as the mind can comprehend. This book comprises 226 checker problems graded from the simple to the complex. —C. L. D.

Wiswell, Tommie and Grover, Kenneth M. *Twentieth Century Checkers.* Philadelphia: David McKay Company, 1946. 186 p. $1.50.

The work of two veteran and America's foremost masters in checkers, this book gives the "whys and wherefores" of modern scientific play. Many games are analyzed and numerous problems posed. —C. L. D.

Adamson, Hans Christian. *Eddie Rickenbacker.* New York: The Macmillan Company, 1946. 309 p. $2.75.

The Rickenbacker family was an example of thrift and perseverance—trying to work and earn as good a livelihood as they could. The happy picture of the family around the fireside and table at night is reminiscent of many American homes during the 90's and early part of 1900. All might have gone well but for the sudden death of Eddie's father. With debts and a family to support, Eddie at thirteen years of age, got a job and assumed the responsibility of helping to support the family. "God will look after us—he always has!" his mother would say and that philosophy gave Eddie courage and buoyed him up many times in later years when the way looked difficult and hard.

Eddie planned and secured the employment which seemed best for him at the time. He was always a keen competitor and one of his chief characteristics was not only to be one of a team but the leader. This was true in work, sports such as auto racing, and in war, then later in the business field.

THE NEW

NEW WORLD OF CHEMISTRY

By Bernard Jaffe

1947 Edition

The release of information on research carried on during the war has made obsolete most textbooks in physical sciences published before 1946. Accordingly, *New World of Chemistry* has been completely rewritten, redesigned, and re-illustrated.

While the revision is thorough and brings the book abreast of the most recent developments in chemistry, we have retained and improved all the features which made earlier editions so noteworthy.

SILVER BURDETT COMPANY

New York Chicago San Francisco

Patronize our advertisers. Tell them that you saw their advertisement in Science Education

By the time he was twenty-seven years of age, he was in maturity of mind and in accomplishment a middle-aged man. His ability to plan and think through and overcome problems are enumerated step by step throughout the book. From youth until the climax of the book, his rescue in the South Pacific, he was and is a hero much to be admired by all who know him.

The author seems to have the ability to tell the reader the facts with just the right sequence and emphasis. From the time you pick up the book, you read and want to keep on reading until you have read the whole story—the story of Eddie Rickenbacker. It is a fine book for any boy or girl. —F. M. D.

HILER, HILAIRE. *The Painter's Pocket Book of Methods and Materials.* Los Angeles: Research Publishing Company, 1945. 256 p. $2.50.

This is a treatise on methods and materials used in painting. Principles involved are explained. The material on pigments and the problems of colors as viewed from the standpoint of art should be of special interest to science teachers teaching color. —S. M. A.

MULAC, MARGARET E. *The Game Book.* New York: Harper and Brothers, 1946. 385 p. $2.50.

Science club sponsors, teachers, program chairmen, camp directors, and recreational leaders will find here more than six hundred games and hundreds of game ideas. Drawings and diagrams supplement the textual material.

Many tricks and stunts are described—"mind reading", simple magic, word games, puzzlers, pantomines, carnival ideas, and so on. By its use, science club sponsors can do much to enliven their programs and social hours. Alphabetical indexing adds much to the use of the book. High school librarians will find this "a much sought after" book. —G. E. D.

LEEMING, JOSEPH. *Fun with Puzzles.* Philadelphia: J. B. Lippincott Company, 1946. 128 p. $2.00.

It would take a smart person, a quiz kid, to correctly solve all of the puzzles listed in this book. But it is fun trying even if you cannot answer them all.

Puzzles include problems with coins, counters, matches, mathematical and number puzzles, pencil and paper problems, brain twisters, cut-out and put-together puzzles, anagrams and word puzzles. Answers are provided in the back for all those finding themselves a little "rusty".

This is a fine book for science club members and all who like to solve puzzles and puzzling problems. —G. B. K.

WELLS, EVELYN. *A Treasury of Names.* New York: Duell, Sloan and Pearce, Inc., 1946. 326 p. $4.00.

A Treasury of Names contains approximately 15,000 names, their variants and derivatives. Each name is given its origin, history, background, mythology, etc.

The author believes that names for children should be selected by parents more carefully than is often done. Names can often be real handicaps to the possessor. *A Treasury of Names* permits a wide, if not wiser, selection.

—G. B. K.

MEISTER, MORRIS, KEIRSTEAD, RALPH E. AND SHOEMAKER, LOIS M. *The Wonderworld of Science,* Book Nine. New York: Charles Scribner's Sons, 1946. 698 p. $2.20.

This completes an outstanding series of elementary science and junior high school books, the others of which have been previously reviewed in *Science Education.* The theme of Book Nine is *Science for a Better World.* While seemingly much difficult material has been introduced, such as atomic structure, television, synthetics, photoelectric cells, radio, radar, D. D. T. and so on, the authors believe every student using the book is capable of understanding the basic principles of science. They say this is especially true if the course in science has been sequential from grade to grade. The social implications of science, problems of health, the methods of science, and conservation have also been emphasized.

The material is organized into ten teaching units: (1) Materials of the earth, (2) Plant life on the earth, (3) Animal life on the earth, (4) Man on the earth, (5) Better health through science, (6) Overcoming the effects of the weather, (7) Our supply of energy, (8) Doing the work of the world, (9) Communication and transportation, and (10) The orderly universe. Each chapter has a How Much Do I Remember test, a page of challenging Problem Pictures and a list of Things To Do. Many experiments, demonstrations, projects and problem-solving activities are included.

There are 364 pertinent illustrations and photographs. A glossary defining more difficult words and indicating their correct pronunciation is included. The paper and type used should both contribute to making reading easier and in reducing eye fatigue.

The authors are to be commended for writing a series of such unusually fine and attractive science books. By every standard of consideration, they are entitled to wide usage.

—C. M. P.

FARADAY, JOSEPH E. *Encyclopedia of Hydrocarbon Compounds,* Volume I: C_1 to C_6. Brooklyn: Chemical Publishing Company, 1946. Unpaged. $15.00.

This book will greatly simplify and expedite literary research in hydrocarbons C_1 to C_6. Other volumes are to follow. The following information is presented: molecular formula, structural formula, occurrence in nature, names of the compound, all known methods of preparation with

complete bibliography, physical constants, methods of detection and determination, and outstanding properties and reactions.

—C. L. D.

Hopkins, B. Smith, and Bailar, John C. *Essentials of General Chemistry.* Boston: D. C. Heath and Company, 1946. 520 p. $3.50.

The outgrowth of the authors' many years of teaching chemistry at the University of Illinois, they state the two chief objectives of a course in general chemistry as: (1) to give the student an appreciation of the importance of chemistry and (2) to teach him to reason logically and scientifically. The first of these objectives stresses the acquisition of factual knowledge—the mode of preparation of important substances, their characteristics and the uses for which these characteristics fit them. The second objective emphasizes principles—atomic structure, ionization, reduction, and so on.

Unit basis methods and factor methods of solving chemical problems are emphasized in preference to the use of proportion. Reading lists are included. The content is similar to that found in most college chemistry texts. For a relatively brief book, there seems to be a remarkably complete coverage.

—S. M. A.

Perry, Josephine. *The Petroleum Industry.* New York: Longmans, Green and Co., 1946. 129 p. $2.00.

The aim of this book is to give a true picture of the magnitude and importance of an industry which so vitally influences the life of the people. The author gathered the material as much as possible from the industry itself. This was done to insure the authenticity of the book through access to the latest available facts about an industry whose amazing growth during the last three decades has no peer in industrial history.

Josephine Perry has written books on the following industries: chemical, coal, cotton, electrical, fish, glass, paper, petroleum, rubber and steel. She collaborated in the writing of forestry and lumbering and milk production. All of her books contain illustrations and captions of great value and interest. Here is an example of the readability of the book:

"Late in the afternoon of August 27, 1859, Drake's Folly became the first commercially productive oil well in America. Toward sunset that day Uncle Billy Smith and his son Sam (who were drilling for Drake), stopped work to measure the depth of the well. They were astounded to see that crude oil gurgled to within a few feet of the top of the casing. They used a tin pitcher to bail out a sample of the oil.

THE ORIGINS AND HISTORY OF THE MAYAS

By M. WELLS JAKEMAN, Ph.D.

". . . may be said to make one of the greatest contributions yet made in an archaeological field that has proven so baffling."

—Science Education

". . . Far surpasses in depth and scope the dimensions of a purely speculative work . . . amply demonstrates Mr. Jakeman's superb talent for the systematic organization of material."

—American Anthropologist

". . . Mr. Jakeman's methods are clearly excellent." —Tlalocan

Vol. I, No. 3 (1944), p. 266

CONTAINS:

- A careful summary of the present archaeological knowledge based on established facts;
- A survey of documents bearing on the Mayas, with sample texts and translations of some of the important documents;
- Full description of the famous Mayan calendar;
- An evaluation of the various systems correlating the Mayan and Christian calendars;
- About 150 carefully selected references.

In Three Parts

Part I. Introductory Investigations, Now Ready
$3.50

RESEARCH PUBLISHING COMPANY
206 S. Spring St. Los Angeles 12

Taking the sample in a gallon jug, Uncle Billy mounted a mule and rode away to Titusville (Pa.) to spread the news of the first oil well in the United States. A new industry was born —a great industry."

Now with state, interstate and federal conservation laws, rules and regulations the time has passed when oil wells were allowed to flow at capacity and reckless over-production of crude oil was permitted to waste one of our most valuable natural resources.

There are four main divisions of the petroleum industry: production, transportation, refining, and marketing. These are all fully discussed.

Petroleum science will grow and better engines and better motor fuels gradually will evolve.

This is an excellent book for junior and senior high school students. —F. M. D.

PERRY, JOSEPHINE. *The Paper Industry.* New York: Longmans, Green and Company, Inc., 1946. 128 p. $2.00.

The great modern paper mill is engaged in a manufacturing process from the log to the converted product. From the time the pulpwood leaves the sawmill until the paper is made, millions of gallons of water are used. The water must be pure and colorless for if it is impure bacterial growth will spot the paper and undesirable coloring matter will discolor it.

Barking the pulpwood is a very important process, for high quality paper cannot be made if bark gets into the pulp.

Logs cut from the tree trunk midway between butt and top usually produce the best pulpwood, because that portion of the tree has the longest fibers, straightest grain and fewest knots. Different parts of this best section make better chemical pulp than others, just as the quality of the pulp depends, also, on the type of wood selected.

The three paragraphs above are examples of the factual material in this small book which is of importance in the paper industry.

One of the new developments in the paper industry is the recognition that trees for paper making can be "cropped" scientifically and assure profit and permanency. Also, in the south it is interesting to note that an acre of southern pine trees can produce three times more cellulose than an acre of cotton. The American housewife is aware of new developments in papermaking such as the paper fruit wraps, vegetable parchment, V-boxes, and Locker-seal, used especially to wrap meats to be stored in freezing units. The United States takes first place in papermaking among the nations.

—F. M. D.

TALLANT, ROBERT. *Voodoo in New Orleans.* New York: The Macmillan Company, 1946. 247 p. $2.50.

This is a history of voodoo worship in New Orleans. It tells of the famous Voodoo queens and witch doctors, and describes the orgies and ceremonies of the cult. Voodoo (or hoodoo, as many believers often call it) seems to be a strange mixture of superstition and a sort of religion. Curiously enough, many of its believers (estimated at about one-third) are whites. Although more likely to be confined to the more ignorant, such is not always the case. The power of suggestion seems to be the basis of much of voodoo practice. And certainly commercialized Voodoo attained almost unbelievable power in New Orleans for nearly a century. Its practice and belief is by no means confined to New Orleans, and one rather suspects its adherents are found everywhere. As such, it poses a real problem for education. Rooted as it is, its elimination is likely to prove to be an extremely slow process.

The author explains Voodoo gris,-gris, charms, sinister practices, how a person is *fixed, hexed,* or *crossed.* While much of it is ignorant superstition, spawned in a race of jungle people and carried with them to what we call civilization, it is not always harmless. Much crime and many deaths have resulted from it.

—C. L. D.

CARINGTON, WHATELY. *Thought Transference.* New York: Creative Age Press, 1946. 287 p. $2.50.

Much experimental work has been done on telepathy. The most notable work that has been done in this country is that by Professor J. B. Rhine of Duke University who has been doing research in this area for many years and reported some time ago in his book *Extra-Sensory Perception.* The author of this book is a Cambridge psychologist internationally recognized as an authority in the field of Psychical Research and cognate subjects, which have been his principal study for some thirty years.

The earlier studies in the field are summarized including that of the author. He explains his Association Theory of Telepathy and the experimental evidence upon which it is based. He points out some possible objections to the theory and attempts to answer them. However, before most other psychologists and educators accept either the theory itself or even the authenticity of the experiments themselves, much confirmatory evidence must be obtained by many other investigators. This does not negate the work of Carington, Rhine and others and they are to be commended for honestly investigating the possibilities and facts in a most important area of human activity.

There are two chapters on the problem of survival, theology and religion. The author believes it is possible not only to prove survival, but even to find out something about it, especially the *How.*

—S. M. A.

MORRIS, MARK. *Career Opportunities.* Washington, 2153 Florida Avenue: Progress Process, 1946. 254 p. $3.25.

One hundred leading occupations selected primarily from those fields which have substantial postwar possibilities, constitute an integral part of the nation's economy or offer special advantages to veterans are described. The author states that this book represents the best thinking and the most reliable knowledge of Uncle Sam's occupational specialists in the Agriculture Department, Labor Department, National Roster of Scientific and Specialized Personnel, Navy Department and the War Department. It is an excellent book for anyone seeking information about specific occupations, for vocational guidance teachers, and those counseling war veterans and college students.

About each occupation is information on: what do ———— do; how do you qualify as a ————; who should or should not become a ————; where do ———— work; what do they earn; and what is the outlook?; where can you prepare for ———— and what subjects do you need?; where can you find out more about ———— and related education; what jobs are related to ————?

The following large occupational areas are discussed (each broken into numerous suboccupations): industry, business, agriculture, engineering, physical sciences, natural sciences, medical sciences, social sciences, modern arts, education, religion, and miscellaneous.

—R. J. A.

PODOLSKY, EDWARD. *Doctors, Drugs and Steel.* New York: Bernard Ackerman, Inc., 1946. 384 p. $3.75.

This is the latest in a series of medical books written by Dr. Podolsky, a doctor of long experience. He has uncommon skill as a writer and *Doctors, Drugs and Steel* tells the story of man's struggle against disease and pain. The eleven sections of the book, each a complete story in itself, together form a broad survey of the entire field of modern medicine.

The major aspects of the book include: (1) The heart menders, (2) Healers of the brain, the mind, and the nerves, (3) The lame, the halt and the blind, (4) The four scourges, (5) The breath of life, (6) The story of childbirth, (7) Miracles with blood, (8) The war on poisons and bacteria, (9) Doctor nature, (10) New methods of detecting disease, and (11) The march of medicine.

Numerous case histories and illustrations, medical lore and health practices make the book unusually interesting reading. It is a book you

1946 EDITIONS !

The *Vitalized Series* of 2-color concise texts

VITALIZED GENERAL SCIENCE ***Just published.*** Simple language, thorough explanations of fundamentals, a profusion of unusual 2-color diagrams, adequate captions, sensible organization—a student's guide to the meaning of science.

VITALIZED CHEMISTRY ***Now with Atomic Energy.*** The atomic theory chapter completely rewritten, newly illustrated, to include nuclear reactions, the mass-energy relation, the chain reaction. Latest information on plastics, drugs, metallurgy.

VITALIZED PHYSICS ***Now with Radar, Jet Engines, Rockets.*** New diagrams get down to the principles of these revolutionary developments.

VITALIZED GENERAL BIOLOGY **Up-to-Date.** References to new drugs, eye banks, the problem of aging.

Each Title 65c net to Schools

For your free examination copy, write to

COLLEGE ENTRANCE BOOK COMPANY

104 Fifth Avenue New York 11

Patronize our advertisers. Tell them that you saw their advertisement in SCIENCE EDUCATION

would be loathed to lay aside and not finish reading after you have once begun. It is a fine book for any layman, teacher or student, high school or college. —C. L. D.

ERNST, MORRIS L. *The First Freedom.* New York: The Macmillan Company, 1946. 316 p. $3.00.

The first freedom is freedom of speech and expression—everywhere in the world. Some interesting facts given by the author to show that our first freedom is in danger are: "Ten states have not a single city with competing daily papers. Twenty-two states are without Sunday newspaper competition. Fourteen companies owning eighteen papers control about one-quarter of our total daily circulation. Three hundred and seventy chain newspapers own about one-fifth of all our circulation. More than a quarter of our daily circulation is absentee-owned. We have a thousand less owners than a decade ago. Thirty-two hundred weeklies—the backbone of local democracy—have disappeared. One company dominates more than 3,000 weeklies. There are only 117 cities left in our entire nation where competing dailies still exist."

"The weekly attendance at movies amounts to more than 100 million people. But five companies control the 2,800 key theaters of the nation. Too few people are gaining control over the minds of 140 million people."

"The democratic process requires two tools—literacy and means of communication. Out of the 2 billion persons on this planet, 60 per cent or about 1,200,000,000 persons are still totally illiterate. There are only about a score of nations validly claiming 25 per cent literacy." Americans must watch well their freedom of speech in newspapers, books, radio, and advertising, or they will lose it.

Morris L. Ernst (once adviser to Roosevelt), lawyer and writer, was born at Uniontown, Alabama, in 1888, and received his education at Williams College and New York Law School. —F. M. D.

FORD, COREY, AND MACBAIN, ALASTAIR. *Cloak and Dagger.* New York: Random House, 1946. 216 p. $2.50.

This is the secret story of the O. S. S.—Office of Strategic Services, the first espionage office the United States ever has had. It was one of the top secret agencies of the war. Recruited from every walk of American life, its agents were dropped behind every enemy front in the world. Here they rendered invaluable service of every description.

Cloak and Dagger in detective-book fashion enumerates many of their valuable and dangerous exploits. The episodes described in this book are based on first hand exploits of the two authors, interviews with O. S. S. personell in the field and on first official Washington records only recently released. This silent, thoroughly efficient organization rendered a most distinct service to the success of America's fighting forces. This record of honor is vividly portrayed in *Cloak and Dagger* which will later appear in pictures on American screens. —G. B. K.

GRISCOM, LUDLOW. *Modern Bird Study.* Cambridge: Harvard University Press, 1945. 190 p. $2.50.

The author of this book is Chairman of the Board of the National Audubon Society. It is the result of the author's thirty-seven years of active field work with nearly 2,500 different birds found throughout the United States, Western Europe, West Indies, Labrador, Newfoundland, Central America, and the north coast of South America. He reviews briefly the history of the study of birds, then the emotional life of the birds, the level of their intelligence, adaptibility and the causes, origins, and routes of their migrations.

The reader will be interested in reading about the passenger pigeon and reasons for its extinction, and that of the Carolina parakeet and other species of birds that are threatened with extinction.

He gives as a cause for periodic migration surplus population. The arctic lemmings, a mammal, is a good example. After a favorable number of years they become so abundant in one section or another of Arctic Europe that they move southward, eastward, or westward. These wandering lemmings encounter all sorts of disasters and dangers, and probably the great majority of them never return from where they came and perish miserably. But in this way the surplus population is greatly reduced. This migration caused by a surplus population, as in the case of lemmings, is inferred in birds, but has not as yet been really proven.

The study of birds requires care and patience. It is not safe to deal in generalizations. There must be proof and evidence sufficient to prove one's statements. The more scientific the study of birds becomes, the more valuable will our knowledge of them become.

He mentions that psychologically, from the observer's or the recorder's standpoint, birds are rarer when he is a beginner, and they become commoner as he becomes more experienced. The chapters on distribution and classification are more technical than the first five chapters, and some knowledge of North American birds must be taken for granted.

The main object of the book is to show that the study of birds is not only a branch of scientific research, which need not be a narrow speciality, but that it also contains many topics of interest to the layman and that the growing army of bird watchers have, and can, really assist the ornithologist in solving problem after problem by controlled, careful, and thorough observation. —F. M. D.